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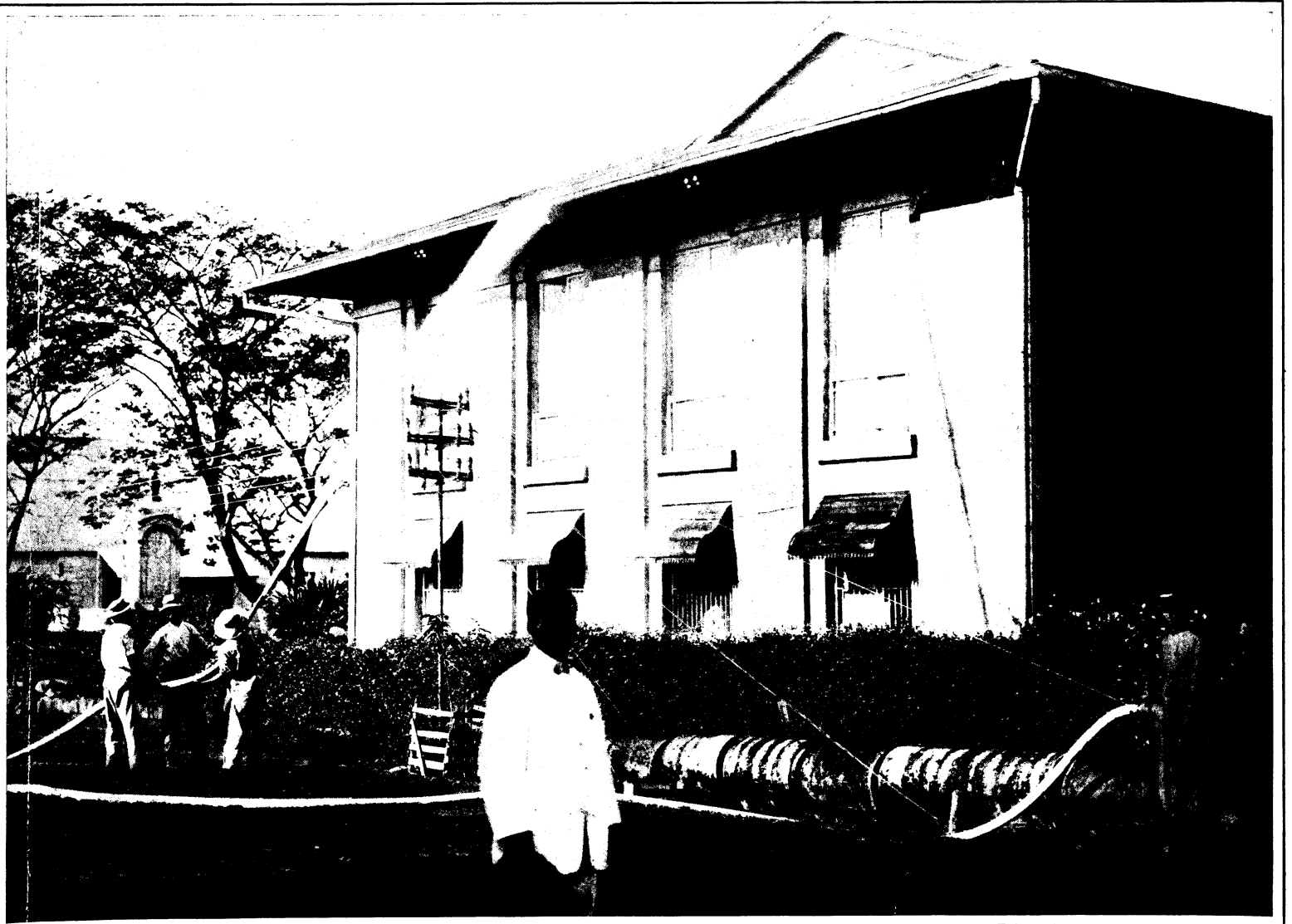


Quarterly Bulletin

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Malvar Waterworks, San Pablo, Laguna, testing for fire pressure.

QUARTERLY BULLETIN

BUREAU OF PUBLIC WORKS
MANILA, P. I.

ISSUED QUARTERLY BY
THE CONSTRUCTING DIVISION, UNDER THE DIRECTION OF
THE DIRECTOR OF PUBLIC WORKS

C. A. TANSILL, COMPILER OF STATISTICS

The objects of the QUARTERLY BULLETIN are:

1. To show each engineer and employee of the Bureau of Public Works the work of the Bureau as a unit.
2. To show him that his work is a unit part of the whole.
3. To make clear to every provincial and municipal official and to the people the work being done by the Bureau.
4. To make the work of the Bureau of personal interest to all.

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THEORY AND PRACTICE

In Montana a railway-bridge had been destroyed by fire, and it was necessary to replace it. The bridge-engineer and his staff were ordered in haste to the place. Two days later came the superintendent of the division. Alighting from his private car, he encountered the old master bridge-builder.

"Bill," said the superintendent—and the words quivered with energy—"I want this job rushed. Every hour's delay costs the company money. Have you got the engineer's plans for the new bridge?"

"I don't know," said the bridge-builder, "whether the engineer has the picture drawn yet or not, but the bridge is up and the trains is passin' over it."

—Harper's Magazine

ECONOMICS OF BRIDGE CONSTRUCTION.

Prepared by H. V. MILES and W. J. GRODSKE, Read at the Engineers' Conference, Baguio, January 4, 1916.

Bridges may be divided into three classes according to the type and the materials of which they are constructed, known respectively as (1) Temporary, (2) semi-permanent, and (3) permanent. It is purposed to present each class and then to detail the various conditions governing the choice of any one class over the remaining two:

Class.	Materials.	Type.	Road surface.
(1)--- { Temporary. Life usually under 10 years. }	Timber ---	{ Pile trestle with fixed deck. Pile trestle with collapsible deck superstructure. Truss superstructure ---- }	{ Planks. Tar macadam on plank. Macadam on concrete. City pavements on concrete. }
(2)--- { Semi-permanent. Life 25 to 50 years. }	Steel -----	{ Beam superstructure ----- Truss superstructure ----- }	
	Concrete ---	{ Reinforced-concrete girder superstructure on reinforced-concrete piles. Reinforced-concrete girder superstructure on abutments and piers. }	
(3)--- { Permanent. Life over 50 years. }	Concrete --	Arch superstructure -----	{ Macadam or city paving. }

The various items which determine the choice of the class may be divided as follows:

- (a) Cost including capitalized maintenance and renewals.
- (b) Traffic.
- (c) Justification of bridge project as against ford or ferry.
- (d) Comparison of projects as to merit.

A study of the Laoag Bridge will clarify these determinations. This bridge is chosen because it represents the largest highway bridge constructed in the Islands up to the present time, as well as being situated in the comparatively poor Ilocos country.

The first step would be to investigate the traffic by means of a census, which follows:

Traffic census (ten-day period), October 20 to 29, 1915.

	Number.	Toll unit.	Totals.
Automobiles (trucks).....	103	P1.00	P103.00
Automobiles (touring).....	274	.50	137.00
Carromatas.....	423	.05	21.15
Light rigs.....	14	.10	1.40
Carts (loaded).....	970	.10	97.00
Carts (empty).....	806	.05	40.30
Wagons.....	18	.10	1.80
Cycles.....	110	.05	5.50
Animals.....	2033	.05	101.65
Pedestrians.....	32604	.01	326.04
Total on basis of ferry tolls for ten days.....			834.84
Total for one year (365 days).....			30,472.00

These traffic figures are considerably below the average, the period under consideration being the light traffic season. Notwithstanding this, the average daily vehicular traffic was 260 carts, carromatas, 4-wheeled rigs and automobiles.

Taking the life of this bridge as fifty years, as a semi-permanent bridge was used, the cost is more than justified through its earning power. The project complete cost approximately P203,000. This expenditure is justified as seen from the following, with maintenance and sinking fund figured at 4 per cent compounded annually.

Paint to be renewed every second year on 330 tons of steel, at P6.00 per ton.....	P1,980.00	
Annuity for painting P1,980×0.4902.....		P970.00
Floor, first group, to be renewed every tenth year, 70,000 feet b. m. ipil, at P250.....	17,500.00	
Annuity for flooring, P17,500×0.08329.....		1,458.00
Steel to be renewed every twenty-fifth year allowing 10 per cent excess to permit replacement without interference with traffic for over 1 hour at any time, 330 tons at P0.33 per kilogram.....	108,700.00	
Annuity for steel P108,700×0.02401.....		2,610.00
Substructure to be renewed every 50 years.....	102,000.00	
Annuity for substructure P102,000×0.00655.....		668.00
Total annuities.....		5,706.00
Say.....		6,000.00
Incidental expenses, maintenance.....		3,000.00
Total expenses, 1 year.....		9,000.00

Total gross income, 1 year.....	30,000.00
Net income.....	21,000.00
With investment of (cost of bridge).....	₱203,000.00
Probable cost of protecting spillway approach.....	70,000.00
Total investment.....	273,000.00
Net return on investment (₱273,000.00) = 7.7 per cent per year, or.....	21,000.00

On a fifty-year bond, 6.355 per cent is the equivalent of the above investment.

We might also consider the case of building the bridge twice as long as it is in order to avoid the spillway approach and its consequent protection, figuring maintenance and sinking fund at 4 per cent interest compounded annually.

Paint to be renewed every second year on 660 tons, at ₱6 per ton.....	₱3,960.00	
Annuity for painting steel $\text{₱3,960} \times 0.4902$		₱1,941.00
Floor, first group, (ipil) to be renewed every tenth year, 140,000 feet b. m., at ₱250.....	35,000.00	
Annuity for flooring $\text{₱35,000} \times 0.0832$		2,912.00
Steel to be renewed every twenty-fifth year, allowing 10 per cent excess to permit replacement without interference to traffic for over 1 hour at any time, 660 tons at ₱0.33 per kilogram.....	217,400.00	
Annuity for steel $\text{₱217,400} \times 0.02401$		5,220.00
Substructure to be renewed every 50 years.....	204,000.00	
Annuity for substructure $\text{₱204,000} \times 0.00655$		1,336.00
Incidental expenses, maintenance.....	3,000.00	
Total expenses, 1 year, say.....	14,400.00	
Gross income per year.....	30,000.00	
Net yearly income, say.....		15,600.00
This investment represents 2,000 feet of bridge, costing.....	400,000.00	
700 lineal meters of toe protection for 6-foot fill, at ₱140.....	98,000.00	
Total investment.....	498,000.00	
Net return on investment (₱498,000.00) = 3.1 per cent, or.....	15,600.00	

On a fifty-year bond, 8.355 per cent is the equivalent of the above investment. These show that the present bridge with ₱70,000 additional for approach protection as previously outlined is a gilt-edge investment. If the bridge was doubled in length the investment would not have been so justifiable until the country should become more prosperous and interest rates drop from about 8 to 4 per cent.

The first class includes all types of wooden bridges. It is not desirable to utilize this class of construction if one of the other two classes can be substituted. With this object in view written approval of the Secretary of Commerce and Police must be obtained before any structure of this class can be constructed. The best examples of the economy of the utilization of this type are the bridges on the Benguet Road. It was essential that the road be opened in as short a time as possible. The streams are numerous and to span them with either semi-permanent or permanent bridges would have required a vast outlay of funds, and besides would have delayed the opening of the road for at least two years. For this reason Oregon pine truss superstructures and trestles composed of fixed decks on pile bents were utilized.

The Zapote Bridge is another example of this class of construction. During the early days a severe engagement between the American and the Spanish and Filipino soldiers occurred here. During the fighting the Spanish adobe bridge which spanned this stream was blown out, and it was later repaired by putting in a wooden pile bent and superimposing a timber deck. This bridge is still being used at the present time. These examples furnish an illustration of the case where a temporary bridge is justified when it is desirable to open up a road to traffic with no available funds in sight with which to construct either of the other two classes.

The third class includes all structures whose life is over 50 years and only arches are here considered as having such longevity. A study of the San Juan Bridge (Vaughan Bridge) on the Manila South Road near Calamba will illustrate this class very aptly. It consists of two 28-meter reinforced-concrete arch spans, costing about ₱42,000. The traffic census which follows shows the value of this bridge to the public:

	Number.	Toll unit.	Totals.
Vehicles.....	100	₱0.05	₱5.00
Autos (touring).....	25	.50	12.50
Foot passengers.....	200	.01	2.00
Total on basis of value to public (1 day).....			19.50
Total value to the public in one year.....			7,117.50

Taking the life of this bridge at fifty years, the cost is justified through its earning power as seen from the following, with maintenance and sinking fund figured at 4 per cent compounded annually (structure to be renewed in fifty years):

Annuity $\text{₱42,000} \times 0.00655$	₱275.10
Annual incidental expenses, maintenance.....	420.00
Total expense 1 year.....	695.10
Total gross income 1 year.....	7,117.50
Net income per year.....	6,422.40
Net return on investment (₱42,000.00) = 15.3 per cent, or.....	6,422.40

On a fifty-year bond this is equivalent to 16 per cent. This clearly demonstrates the greater economy of building a permanent structure over that of other classes, provided funds are available, traffic justifies the initial expense, and definite and accurate knowledge of stream characteristics are available.

After the choice of class has been decided, the next consideration is that of material. That is, whether the material to be used shall be native or Oregon pine timber if class 1 is to be constructed, or whether it shall be steel or concrete if class 2 or 3 is to be built. A consideration of this phase naturally groups itself under the following:

- Materials—local supply; transportation.
- Timber—locally available; kind.
- Steel—transportation.
- Concrete—sand, gravel and transportation of cement.

If a temporary bridge is to be constructed the problem resolves itself into the kinds of native timber available in the local market, the condition and the price. The question of delivery and the cost to transport the native timber to be bridge site also enters. This cost should be compared with that of Oregon pine, using ipil, yacal or molave end stringers and floor beams purchased either in Manila or at the nearest available market. A comparison of the two will readily show which is the more economical.

If a semi-permanent bridge is to be built, will the material be steel or concrete? This is again, other things being equal, a question of costs. Steel at the present time is very high and will in all probability continue so for the next five years due to the enormous demand for it in Europe not only during the war, but to be followed by the reconstruction period after the war. Freight space is scarce and rates are excessively high. Delivery from the Atlantic seaboard to Manila is a matter of over seven months and uncertain then. This means expense and delay. On the other hand, due to the inauguration of a local mill, cement is cheaper today in the Manila market than ever before. One disadvantage is that this cement is shipped in sacks thereby raising the element of risk considerably, because most of our cement shipments are subject to the destroying action incidental to water transportation. The cement is packed in gunny sacks lined with tar paper and a sample shipment sent to Negros stood up well. However, measures are being taken to pack the cement in barrels.

Provided sand and gravel can be secured at a price within the cost limit of ₱5 per meter, and the problem is only a question of steel versus concrete, a concrete structure will have every advantage under the existing conditions, and these conditions will continue to exist in all probability for the next five years. This presupposes that the other considerations involved which will be discussed under the heading of type are equal, and that it is solely a question of cost of steel versus cost of concrete.

After the class and material have been decided upon there still remains the consideration of the type of bridge, and this requires in a still greater degree an intelligent study of the drainage area and the stream characteristics such as drift, velocity and character of bed.

If it has been decided to build a temporary structure, the question arises as to whether a pile trestle with a fixed deck, with a collapsible deck or with a truss superstructure is preferable.

If the river does not carry much drift and its flood stages are not too high to endanger a fixed deck, this type may be used. Ilocos rivers are good examples of these conditions. If the stream carries considerable drift or if its flood stages are high, the type best suited is the pile trestle with the collapsible deck superstructure. A good example of this is over the Mangaldan River in Pangasinan which rises very rapidly. The extreme high water rises several meters above the

collapsible deck which thereupon floats off the bents and is kept from being carried down stream by cables connecting it to a dead-man. Upon the subsidence of the flood the deck is again placed in position.

In the case of deep gorges where piles are not feasible owing to the lengths required or where the current is swift and carries boulders, the truss superstructure is best adapted as illustrated on the Benguet Road.

If a semi-permanent structure has been decided upon, the question as to whether steel or concrete will be used arises. If the decision favors concrete, the question narrows down to a girder versus an arch, and this is far more difficult to correctly determine than it is to choose the class. While certain considerations determine the latter immediately, it often happens that these two types seem to fit the conditions in an equal degree. A girder structure might be cheaper than an arch, each of which equally fills the requirements and the selection depends entirely upon the reliability of the data. For, while the girder is cheaper, if it is definitely known that the high-water data is reliable, the arch would be far more economical in the end—having less liability to deteriorate than the girder, and also being able to withstand far greater overloading if the future traffic should necessitate.

Girders raise the roadway above that of an arch for the same clearance and if there is any likelihood of scour it is very imperative to keep pile bents and piers out of the stream. Since girders cannot economically be built of greater than 12 or 14 meters span, this of itself generally eliminates them from consideration and usually necessitates a steel or an arch bridge. Where there is any drift of considerable size the reinforced-concrete deck girder on reinforced-concrete piles is never to be considered because the clearance cannot be made sufficiently high owing to the necessity of keeping down the road elevation, and any accumulation of drift which is occasioned by the pile bents will cause the river to scour around the piles even though there had been no sign of scour previous to the erection of the bridge. A possible remedy and one under consideration is to build a reinforced-concrete pile trestle, without handrails and having a tar bound surface high enough to take any ordinary flood, but at the same time low enough so that when the river rises sufficiently to pick up and carry drift, the top of the bridge will be under this high water thereby allowing the drift to flow overhead. With no accumulation of drift and resultant rise of water, the river will not have to scour out a deeper or wider channel to accommodate itself. However, if the bed is composed of boulders, this in itself eliminates the possibility of driving any kind of piles, and it may be necessary to carry down piers to a considerable depth to eliminate the danger from scour. Even under a pier with a comparatively good foundation of clayey sand, it is often found advisable to drive piles because the velocity and amount of water would endanger it by the possibility of scour.

A deep river with high velocity, drift and the possibility of scour would practically eliminate all but a steel bridge on piers with timber piles *even though an arch was desired*. On the other hand in a stream with all the above characteristics except the drift, an arch could well be used. If the same river had a shallow profile, the steel bridge would probably fit best because of the large abutments required by a flat arch and the consequent constriction of the waterway if the latter were used.

A pile trestle—that is, a reinforced-concrete deck girder on pile bents—is never feasible in a river having considerable drift, and several bridges of this type were lost by having the drift lodge above them, thus causing the water to scour out the bents. The latest example of this type of failure was the Argos River Bridge on the Camarines—Albay boundary.

Unless the high water is very reliable a permanent bridge ought to be constructed only after the greatest deliberation, because the next year may bring an abnormally high flood which will cause an undercutting of the foundations to such an extent as to cause failure, as in the case of the "late" San Cristobal Bridge. While considerably deeper foundations might have saved the San Cristobal Bridge it would have been an unnecessary waste in numberless other bridges where the depths *had* been made sufficient for any ordinary conditions that might be expected. By carrying the foundations to a far greater depth

than experience with floods such as occur once in five or ten years dictates, and thus increasing the cost of such bridges 50 per cent or more, it would be possible to found these bridges so securely as to be proof against the action of water. However, to exercise such precaution in the foundations would be wasteful in the extreme, especially so, as with the data at hand one could never say which bridge should be so built and which in the usual manner.

The greater number of failures have been of steel or concrete-pile trestle bridges, both of which types are considerably cheaper than arches, tho less durable. With these cheaper structures a longer chance may well be taken. Considering the Islands as a unit, the percentage of failures has not been large. In fact a certain number of failures is inevitable unless the Bureau of Public Works is expected to waste money in the construction of unnecessarily large waterways. This was discussed in a very able manner by Mr. C. W. Hubbell, at that time chief engineer of the Bureau of Public Works, in the QUARTERLY BULLETIN of January, 1914.

It should be remembered also that the old bridges have had and will continue to have their share of failures. Memory is proverbially short, and the disagreeable features of the "good old times" are quickly forgotten or minimized. That earlier failures of bridges were less frequent is also due to the fact that the larger streams which offer greater liability to loss or damage were not attempted to be bridged except in a very few cases. Of these more ambitious structures, only one, a portion of the old bridge of Spain, remains today. It is true that several large structures exist in Batangas, but the size of the stream is insignificant compared to the opening of the bridge, and the foundation conditions were ideal. In days of free labor, such uselessly large structures were possible, but nowadays prices of labor and materials prohibit such waste.

As a general rule, the study of cost of bridges in the Islands shows that per meter of span for all length of bridges the costs run as follows:

	Average.
Reinforced-concrete girder trestle, from ₱300 to ₱900.....	₱350
Steel trusses, from ₱400 to ₱1,000.....	700
Reinforced-concrete arches, from ₱600 to ₱1,000.....	800

Because of the great variations in the cost of the same types of bridge for different locations, it is difficult to compare various types on the cost basis without regard to specific conditions such as height from roadway to foundation, and character of latter. In general the above table shows average costs superficially.

Although the area of waterway may have been sufficient at any particular point in a river before construction, the effect of a bridge will be to materially decrease the area available. The bridge piers or pile bents not only restrict the waterway but cause eddies which at times are of such magnitude as to scour out the river to such a depth as to endanger the structure. In other cases the interposition of piers obstructing the waterway will cause the water to dam up behind the structure thereby flooding the inhabited sections upstream, which had never been subject to inundation before the bridge had been built. This occurred at the Argos Bridge on the Camarines—Albay boundary, and illustrates the importance of considering the character and class of improvements above and below the site. In other cases where the entire country overflows at every flood, and in cases where only tide water is to be cared for, it will be usually sufficient to build only a comparatively short bridge as a gateway for the water with a causeway approach at either end.

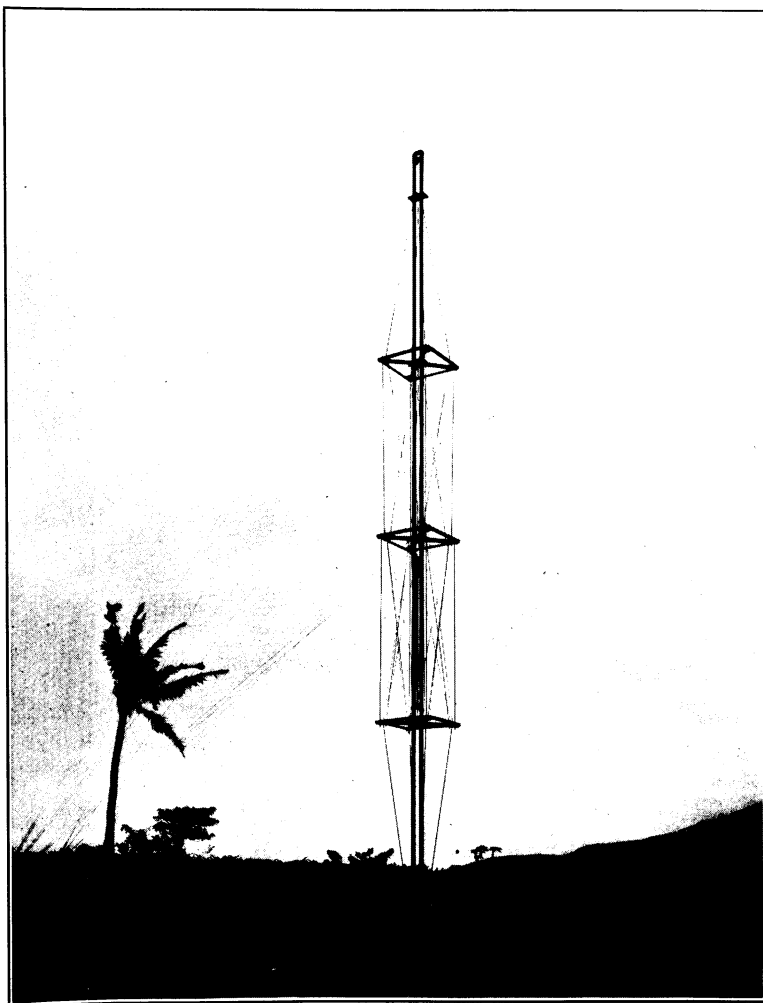
The ends of the road fill are usually well protected by the abutment walls or wing walls. At times when economy must be particularly observed at the expense of a perfectly first-class structure, the wings are slightly shortened and the slopes paved with riprap up to the high-water mark to prevent washing away of the fill. In such cases the riprap should be heavy and carefully placed. In cases where the roadway is inundated in times of flood, particular attention must be paid to the road surfacing, which should be especially paved to keep the surfacing intact while the flood washes over it. It is in cases like this that the herein before mentioned overflow bridge might be of value. Placing a curb on the downstream side of the road at a height equal to the crown of the road will save the road surfacing from being washed away.

It is suggested that engineers submit as accurate data as possible. Too much emphasis cannot be laid upon the high-water mark, character of the soil, borings, drift, danger of scour and the necessity of making a careful economical study before recommending the class and type of bridge for each particular location. Skew spans should be avoided as much as possible, for not only will the required span be longer, but they are more difficult to construct and the cost of plans is increased. Although this paper does not attempt to go into detail it may have at least shown some of the points to be considered in determining upon the structures to be used at the average crossing.

THE "MALVAR" WATERWORKS, SAN PABLO, PROVINCE OF LAGUNA.

By J. R. BARRY, District Engineer, Laguna.
(See title-page.)

In 1912, Hon. Potenciano Malvar, at that time governor of Laguna Province, initiated a movement to provide San Pablo, the largest and most prosperous town of the province, with a modern water-supply system. His plan provided for the bringing to the town by a gravity pipe line of the water of the Cabunsod Spring, located some 6 kilometers east of the town at the foot of one of the spurs of San



Pressure-regulating tower, Malvar Waterworks, San Pablo, Laguna Province.

Cristobal Mountain. This spring had long supplied the town with water by means of a system of canals planned and executed some sixty or eighty years ago by the parish priest.

Funds having been provided for a preliminary investigation and survey it was found that the minimum dry weather flow was practically 2½ million gallons per day, and that the spring was 90 meters

above the mean level of the town, while an analysis of the water by the Bureau of Science showed it to be free of all injurious bacteria or mineral constituents.

The feasibility of the project having been thus established, complete plans of the system and an estimate of its cost were prepared. Meanwhile Governor Malvar had secured the necessary right of way and was busy in his efforts to secure the funds necessary, but it was not until 1914 that he was successful when a loan of ₱50,000 was arranged, and an allotment of ₱15,000 secured, which with the ₱20,000 appropriated from current municipal funds amounted to the sum of ₱85,000 that it was estimated the system would cost.

The system as planned and constructed consists of a reinforced-concrete intake or gate house built over and completely inclosing the



Stream of water flowing from fire hose under ordinary pressure, San Pablo, Laguna Province.

spring; 5,840 meters of 8-inch pipe line from the gate house to the highest point on the hill just above the town on the bank of Lake Sampaloc, a pressure regulating tower at this point, and the distributing system consisting of 500 meters of 8-inch, 1,300 meters of 6-inch, and 2,300 meters of 4-inch cast-iron pipe and 2,000 meters of 3-inch galvanized-iron pipe, with 58 2½-inch fire and 21 public hydrants. The system delivers daily for domestic service approximately 800,000 gallons under a mean pressure in the street mains of 45 pounds and this quantity estimating the population as 8,000 provides a per capita consumption of 100 gallons daily.

The plans having been prepared and approved and the funds secured bids were asked for under the heads of (a) materials and (b) construction, and were opened on June 17, 1914. After considerable discussion the contract for the materials was awarded to the Atlantic, Gulf and Pacific Company, whose bid, ₱57,017.77½, was the lowest

submitted and but ₱200 higher than the estimate of the district engineer. It was decided to do the construction by administration, the estimate of the district engineer (₱17,000) being considerably lower than the lowest bid submitted.

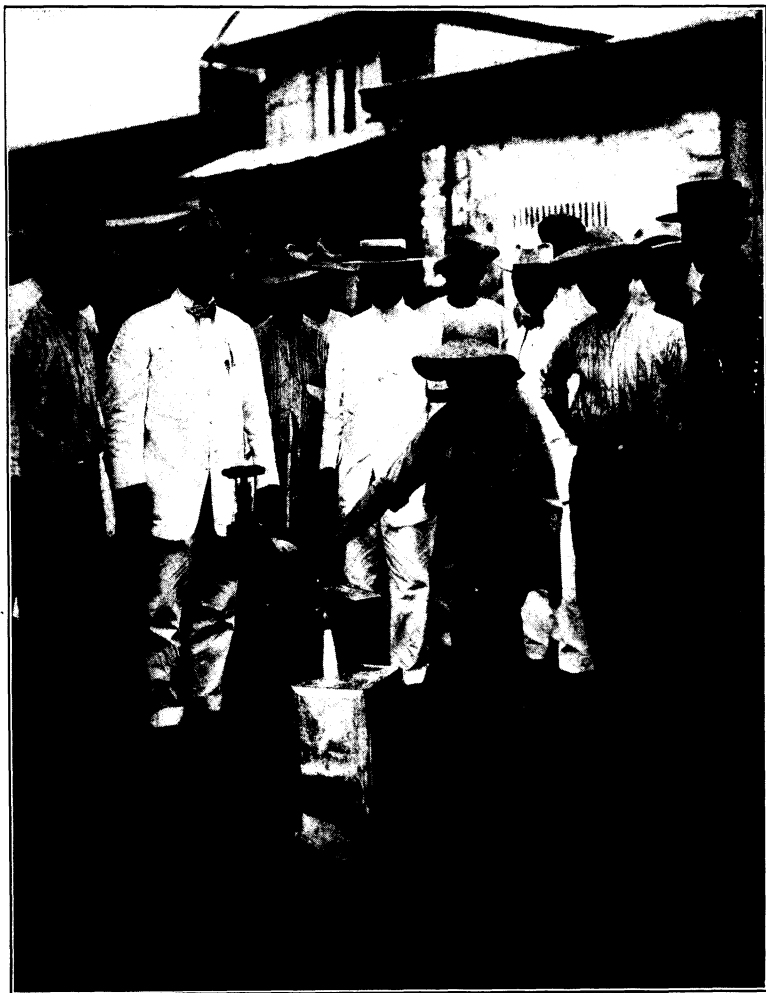
The contract for the material provided that 50 per cent of it should be delivered at the storage yard in San Pablo within 150 days and the remainder within 180 days, "subject however to an extension of time due to any unavoidable calamity," this clause being inserted in order to protect the contractors from delays caused by the European War. The pipe was supplied by R. D. Wood & Co. promptly but could not be shipped on account of lack of transportation facilities until late in December, 1914, and then about 40 per cent of it was jettisoned between New York and San Francisco, where the remainder was transshipped to Manila, arriving at San Pablo on March 16, 1915. The contractors on learning that part of the pipe had been jettisoned

23 feet and the others to 90 feet, each pair being connected at the top by U bends and having air vents at their summits. One of each pair is connected at the bottom with the main 8-inch supply pipe while the other empties into the discharge or waste pipe, there being a gate valve on one of the pipes of the lower pair.

The necessity for and the method of operating the regulating tower may be thus explained. The spring is 66 meters higher than the hill on which the tower stands and 90 meters higher than the center of the town, the town being on a gently sloping hillside. The static head from the spring to the town would give an excessive pressure which would be disastrous to plumbing so that it was necessary either to introduce into the distribution system a safety valve set at a suitable pressure, or else place a waste outlet at such an elevation in the pipe line as would reduce the static pressure to that required for domestic service.

A waste outlet at the elevation of the hill top would not give the desired pressure but by the use of the two lower pipes of the tower the waste outlet was raised 23 feet above the hilltop, and this height added to the height of the hill gives a pressure of approximately 45 pounds for domestic service, as was desired.

The two higher pipes of the tower are brought into use in order to obtain pressure for fire service by closing the gate valve on the lower



Combination of fire plug and public hydrant, San Pablo, Laguna Province.

immediately ordered more to replace that lost but on account of the badly disorganized business and shipping conditions then existing it did not arrive until September 3, 1915, after which the system was soon completed save the laying of the waste pipe from the regulating tower, which work is still held up pending the securing of the necessary additional right of way.

Two features of the system, the gate house and the regulating tower, are more or less novel and merit special mention.

The gate house is of reinforced concrete and is built over the spring so that the water enters directly into the house from the volcanic tufa from which it emerges without being exposed to surface contamination and passes thence into the 8-inch supply pipe, or overflows and wastes, without a possibility of contamination.

The regulating tower is, as stated above, located at the highest point of the hill just outside of the town, and consists of four 5-inch galvanized iron pipes of extra strength, two rising to a height of



Plain fire plug, San Pablo, Laguna Province.

pair of pipe and thus raising the point of waste discharge to the top of the 90-foot tower and adding 30 pounds to the domestic service pressure, raising it to approximately 80 pounds for fire service in the center of the town.

Owing to the railroad station and market being situated in the lower part of the town, that section is growing rapidly, and when the growth of the town becomes such that the water supply under the present system is inadequate, the water that now wastes at the tower will be impounded in a reservoir to be built on the hilltop at such an elevation as will give satisfactory service to the lower part of the town, that will then be served by a separate distribution system, which though separate, will be connected with the present system by valves so that adequate fire pressure can be had in that part of the town when needed.

An analysis of the water is given below:

Water—Chemical analysis and biological examination (Bureau of Science).

MANILA, P. I., February 12, 1912.

Report to Bureau of Health, Manila.

Sample from a flowing spring located 6 kilometers northeast of San Pablo, La Laguna.

Laboratory No., 97081.

Kind of work required: Complete analysis.

	Parts per million.		Parts per million.
Reaction: Neutral.		Nitrogen as nitrites.....	0.001
Total solids.....	209.5	Non-scale-forming ingredients.....	33.4
(a) fixed.....	174.8	Scale-forming ingredients.....	141.4
(b) Loss on ignition after recarbonation.....	34.7	Silica (SiO ₂).....	35.3
Appearance on ignition: white.		Oxides of iron and aluminum.....	1.3
Free or saline ammonia.....	0.009	Oxide of calcium (CaO).....	85.1
Organic or albuminoid ammonia.....	0.014	Oxide of magnesium (MgO).....	8.5
Chlorine.....	12.43	Sulphuric anhydride (SO ₃).....	18.7
Nitrogen as nitrates.....	0.003	Total hardness.....	101.3
		(a) permanent.....	undetermined
		(b) temporary.....	undetermined

Remarks:

NOTE.—Sample of water collected on January 6, 1912, at about 10.30 a. m. by K. H. Davis and J. R. Barry. (Sgd.) J. R. Barry. 4/13/12.

(Sgd.) T. DAR JUAN, *Analyst*.

Biological report (Bureau of Science).

MANILA, P. I., January 22, 1912.

Number of organisms per c. c.....	300
Ciliates.....	negative
Pathogenic bacteria.....	negative
Amoebae.....	negative
Flagellates.....	negative
B. Coli.....	negative

Remarks:

(Sgd.) J. H. FITZBUTLER, *Bacteriologist*.

TESTING MATERIALS.

By G. B. CANAGA.

Read at the Engineers' Conference, Baguio, January 4, 1916.

A favorite definition of engineering states that it is the art of controlling or utilizing the forces of nature for the benefit of man. To accomplish the desired ends, many materials are available; but to insure successful operation of engineering works, the quality of the materials used must be known, both in their relation to the forces to be resisted and to the expenditure of effort necessary to utilize such materials. This latter introduces the element of cost, or the economy of engineering. Another definition of engineering is "making a dollar produce the greatest return."

The correct design of engineering works involves therefore a knowledge of the forces to be resisted and of the physical qualities—that is, strength and durability—of the materials available for construction, and the no less important knowledge of their relative costs. The choice between available materials must depend primarily upon durability against chemical or physical decomposition, and it is here that the first field for testing presents itself, viz, in discovering the qualities of engineering materials. During construction another sort of testing, of the materials and workmanship, is necessary to insure that the designer's intention is properly executed.

Restricting ourselves to the narrower field of structural engineering, after the broad outlines of the structure have been planned with reference to the purpose to be served and the forces to be resisted, the choice of materials, as for instance between reinforced concrete and steel, is offered. Each of the available materials is known to possess certain qualities which have been established by a long series of earlier tests. Such preliminary tests have functions both as guides to the choice of safe stresses in designing and as indications of performance in actual service. Certain materials are standard, in the sense that their strength and durability have been well established. Among these are steel and iron products, cement and various other manufactured products. The results of tests and of experience in manufacture have been embodied in standard specifications, and the only tests here necessary are routine tests to establish the conformity of material furnished with that specified.

Certain other materials of construction depend for strength upon the proper choice and mingling of their ingredients. The quality of sand used in concrete influences largely its strength, as to a lesser degree does the quality of gravel or stone. Tests of these materials are therefore necessary in order to determine what strength may be expected of the concrete, and the stresses to be used in preparing designs. After the preliminary tests required for the

reasonable assumption of unit stresses are made, constant inspection and testing both of material and of workmanship are necessary to insure that the final product as it goes into the job is of satisfactory quality. Another advantage accruing from the testing of such materials as sand and gravel deserves mention. Engineers in the various provinces of the Philippines change with considerable frequency and each engineer should strive to leave for his successor a better collection of data as to the quality of available deposits of sand, stone, etc., than he received from his predecessor.

The foregoing suggests the division of tests into three classes. First, preliminary or research tests to determine the quality of available materials. Second, routine tests on materials purchased, with the purpose of keeping their quality up to that specified. Tests of cement and steel are of this class. Third, check tests to be made during construction, to insure the conformity of the finished product with specification. Under this broad heading comes practically all inspection, which may be considered merely as the testing of workmanship.

It is the intention of the speaker to confine himself principally to the testing of concrete and concrete materials, but incidentally to mention with more or less discussion here and there, certain phases of testing bridge materials in the broad sense, such as the inspection of structural steel, investigation of foundations and the inspection of finished structures to detect deterioration. Generally, the precautions to be observed in sampling, procedure in submitting samples and the interpretation of results will be given greater prominence that the actual manipulation of materials in the various tests.

The tests preliminary to design, for bridges are as follows: First, qualitative and quantitative foundation tests. The former are usually wash borings. Quite frequently information of this sort as furnished to the designing division is unsatisfactory. As a later speaker will cover the subject of apparatus for making such tests, only a few observations as to the extent of the data required will here be made. Borings should be carried deep enough to develop a suitable foundation soil, and enough beyond that to determine the thickness of the stratum or ledge, or should go as deep as the probable penetration of piles where such will be used. The larger the structure, the more important it is to have adequate subsoil data. It may be said, as a general statement, that at least seven borings out of ten coming to the cognizance of the designing division are so shallow as to be nearly worthless and that rarely are enough borings made to develop the foundation properly. These faults are directly traceable to inadequate equipment, a fault which it is hoped may be corrected in the near future. Another contributing feature to this is the lack of experienced personnel and the difficulty of training inexperienced men to do this class of work. In cases where artesian well have been drilled in the vicinity of proposed bridges the materials and formation encountered should be made the part of the data submitted even if these are a considerable distance from the bridge site. In making wash borings samples should be taken dry, that is, in their natural state, and when sent to the district office or to the Manila office for examination, they should be packed in air tight containers to prevent the loss of natural moisture. Quantitative tests of foundation soils are made to determine their bearing power where there is a possibility of soil sustaining a spread foundation. Such tests should be made prior to the preparation of designs, but checked after construction is started and excavation carried to grade. Check borings should be made at that time, to develop the thickness of the bed upon which it is intended to found the structure.

The second, and equally essential series of tests is the testing of concrete materials which the Bureau now requires prior to designs being made. Samples of sand and gravel for testing must accompany requests for designs. After a sufficient number of tests have been made to thoroughly develop the resources of a province in the matter of sand and gravel, the necessity for these tests will be less acute. There is a twofold purpose back of these tests, viz, the selection of materials and stresses properly related each to the other, and the reduction of cost of materials to a minimum. If several sands are available, all should be tested. Form No. 307 has been prepared for sand test reports to be made out and submitted in the same

manner as Form No. 304 for concrete. The information required as set forth on the card is self-explanatory. Cost, quantity available and location with reference to the work are of particular importance. Data on gravel or stone is to be submitted on Form No. 308, no special form having yet been prepared. The same information is desired as for sand. Another object sought in these tests, and one which should be reflected in lower prices for construction, is the ability to tell prospective bidders just what will be required in the way of sand and stone on a given job.

The tests desired in the case of sand are the following:

- Classification; for example, quartz, granite, etc.
- Presence of deleterious substances, such as rapidly weathering minerals, mica, organic matter, excess of clay, etc.
- Granulometric analysis, including determination of uniformity coefficient.
- Percentage of voids.
- Specific gravity.
- Comparative strength of mortar.

For gravel or stone the tests generally desired are:

- Classification.
- Specific gravity.
- Percentage of voids.
- Granulometric analysis.
- Strength of concrete, where failure of coarse aggregate occurs.

This latter is best determined on a very rich concrete mixture, say 1-1½-3.

In sand and gravel tests, the securing of a representative sample is most important.

If sand occurs in a bank, it should be sampled by cutting a vertical trench along the bank face in one or more places, taking the resultant samples and thoroughly mixing them. The mixture is then piled up in the form of a cone, quartered, and opposite quarters rejected. The remainder is again mixed, piled and quartered, the process being repeated until a small enough sample is obtained. The original quantity should never be less than two or three cubic meters.

In sampling beach sand, the same process of quartering and rejecting is to be followed, except that pits 4 to 6 feet deep, or to the depth from which sand will be taken during construction should be the source of supply. The surface sand is usually fine, while that at greater depths is coarser. An instance occurred recently where a sand sample, apparently from the beach surface, was declared unfit for concrete, while a sample from the same beach taken at greater depth was found to be satisfactory.

River sand and gravel should be sampled in the same general way. The constant endeavor must be to secure samples representative of the deposit, and during construction to keep the materials used up to the samples submitted in quality.

It is suggested that a duplicate sample be retained, for each sample submitted, for comparison with the results obtained, and to check up the aggregates delivered for use on the job.

The samples of sand and gravel, if accompanied by concrete specimens as hereafter described, should contain about two gallons each. Sand should be packed in air-tight containers. The determination of organic matter is of doubtful value if the sample has been allowed to dry, and when it is remembered that as little as 0.1 of 1 per cent of organic matter in sand will lessen the strength of mortar materially, the importance of air-tight containers becomes evident.

At the same time, concrete cylinders 8 inches diameter by 16 inches length should be submitted for test. This reduces the quantity of sand and gravel necessary for tests, and results in a lower cost for both freight and testing. Three cylinders of each of the following mixtures should be submitted, using the sand and gravel which in your opinion is best suited by quality and cost for the work in hand:

1. Class A, in the standard 1:2:4 proportion.
2. Class C, in the standard 1:3:6 proportion.
3. Special, proportioned by Taylor and Thompson's method for maximum density (see pages 211, 213, "Concrete Plain and Reinforced," 2d edition).

4. Class A, as modified by B. P. W. specification for excess cement.

In preparing specimens it should be remembered that B. P. W. specifications for concrete proportioning call for cement to be measured by packed barrels, sand and gravel loose measurement (struck), thus giving a richer mixture than is obtained by purely volumetric proportioning. To get the same sort of mixture, cement used in making up test specimens should be weighed. Assume 1 cubic foot of cement to weigh 100 pounds which is practically correct for nearly all Portland cements. Be certain that the cement used has not deteriorated from age and exposure. Concrete should be mixed a little less wet than on ordinary construction. On account of the relatively small size of the test specimens, it will be necessary to use greater care in spading and tamping than is usually done on the work.

The preparation of specimens of mixture No. 4 involves the determination of voids of sand and gravel. What is wanted is not necessarily the absolute percentage of voids but an easily made determination, the results so obtained bearing a nearly constant ratio to the absolute voids. It is recommended that the determination be made by adding the sand or gravel to water. Take a cylindrical container, about one third full of water and add sand or gravel, shaking gently during the process, until the surfaces of the sand or gravel and of the water coincide. Call the depth of water W , and the depth after the sand or gravel has been added, H , then $\frac{W}{H}$ is the percentage of voids. The percentage so obtained will not be the absolute voids but will be sufficiently accurate if care be taken to compact the aggregate, and to exclude trapped air bubbles. The percentage of voids in the combined aggregates may be taken as 110 per cent of the product of stone voids by sand voids, all expressed decimally.

The following covers the principal points to be observed in collecting and submitting samples of concrete aggregates. As criteria for judging their quality from the report of analysis, the following is submitted:

Sand.—Should be free from minerals subject to rapid weathering, or having distinct cleavage. Should not contain mica. Coral sand is generally worthless. Should not contain over 0.1 per cent, and preferably not over 0.05 per cent of organic matter. Should not contain over 5.0 per cent clay. Uniformity coefficient should be 4.2 or greater. In general, the sand having the highest uniformity coefficient is best. Specific gravity not less than 2.60. Percentage of voids should not exceed 40.

Gravel or stone.—Should not show weathering. Surface should be at least slightly rough, and should be free from residual clay, or foreign substances coating the particles. Specific gravity, 2.60 or greater. Percentage of voids not over 45, and preferably 40 or less. Granulometric analysis should show that 60 per cent or more is of large size, and most of the remainder is quite small.

Strength of concrete specimens in compression, at 28 days:

- Class A—is expected to develop 1,600 pounds per square inch.
- Class B—1,360 pounds per square inch.
- Class C—1,120 pounds per square inch.

Passing now to tests made to insure the quality of purchased materials, it will be found that steel products and cement comprise the bulk of such materials tested. Steel testing is necessarily done by bureaus having inspectors at the manufacturing centers. We call for the certificate of inspection of a reputable testing laboratory, on structural and reinforcing steel, roofing and similar products. On occasion, tests of galvanization, etc., have been made for us by the Bureau of Science.

Cement testing is, however, carried on locally. The method of sampling is well known, and the interpretation of results of the physical tests was the subject of a recent circular. These matters will not be discussed. In the past, it has been the practice to test one barrel in each ten of a given lot. This is a much greater number than is usually tested by American engineers, but owing to conditions of shipment to the Philippines, it can not well be reduced.

In a single lot of cement, we frequently get portions of several shipments, and find considerable variation of quality. To insure reasonable uniformity, it has been specified that the entire lot represented by one series of samples should be rejected if—

- (1) More than 10 per cent of the samples fail in tensile strength.
- (2) Any sample fails in soundness.
- (3) Any sample fails in tensile strength by more than 15 per cent.
- (4) Any sample shows retrogression in tensile strength from 7 to 28 days.

The chemical tests are made upon a single sample, prepared by mixing portions from every individual sample of the series, and, of course, the entire lot represented stands or falls upon the single test. It is manifestly unreasonable to reject ten, and only ten barrels for each sample failing to pass, and it is believed that our present specification is an advance over former practice.

Past practice has been to test only every fourth sample for soundness. This test is considered of even greater importance than that for tensile strength, since it indicates the probable durability of concrete made from the cement. On this account, we now have every sample tested.

The last group of tests comprises those made to guard against deterioration of materials, and to insure workmanship of acceptable quality.

Cement should be watched carefully, to detect deterioration from exposure. Conditions of shipment and storage are such as to render this imperative.

Sand and gravel should be checked from time to time, against duplicates of the samples tested and passed. The usual field tests should be freely made. Recent engineering literature, especially the periodicals, abound in suggestions for such tests and apparatus for making them.

Concrete specimens should be regularly prepared, and those retained should be studied in comparison with the results reported. This will benefit future work especially.

Structural steel requires certain "tests," which may properly be considered inspection. Shop inspection determines conformity to manufacturing specifications, correctness of details, and, usually, fitting of parts. In general, shop rivets give little trouble, due to liberal use of erection bolts, and the use of pressure riveters instead of hammers. Field connections give more trouble, and should be closely inspected. The causes of defective riveting are—

1. Use of an insufficient number of erection bolts, to hold the pieces to be riveted, firmly together.
2. Unfair holes, or excessive reaming, resulting in the rivet only partially filling the hole.
3. Insufficient pressure in "bucking up."
4. Insufficient length of rivet, resulting in defective head, and poor bearing under head.
5. Careless driving.

All of these result in loose rivets, or poor heads. The latter can be picked up by visual inspection, but the former must usually be tested for. If one has sufficient experience, he can usually tell loose rivets by the sound when tapped. A better and surer method is the following:

"Strike the rivet head sharply with a hammer. If loose, this forces it to the opposite side of the hole. Place the thumb so that it bears against the same side of the rivet head, and against the plate, and strike again on the opposite side of the head. An extremely slight motion can thus be detected. A 10 or 12 ounce hammer should be used.

"It should be remembered that a loose rivet can only take stress after all of the tight ones have failed, and is therefore useless. Judgment in cutting out rivets, as in all other things, should be used. A single loose rivet, in a connection having 30 or 40 rivets, can do little harm; in fact, cutting out might do more."

If a final digression into the field of inspection may be permitted, the speaker would like to point out the necessity for investigating

foundations, especially those of concrete-pile bridges, after floods of any magnitude. A number of these structures have been found to cause scour to such a degree as to endanger the piles. A "stitch in time" will sometimes save building a new bridge. The obvious preventative for scour is riprap of heavy stones. Cases of unusual scour, as well as high-water marks above those shown in the plans, should invariably be reported to the Manila Office, as these have an important bearing on future designs.

A word as to the cost of the laboratory tests mentioned in the foregoing, may not be amiss. After considerable discussion, the Bureau of Science has established a very reasonable schedule of fixed prices for cement, sand and concrete tests. This will be the subject of an early circular letter.

Paint materials for structural steel bridges are often tested on the designing division's initiative, but the bill for testing is generously passed along to the province for whose benefit the test is made. To play safe, district engineers should allow about ₱35 for the cost of such tests, in addition to the contract price of the steel.

The speaker has endeavored to confine himself to those portions of testing which fall to the field engineers. Laboratory methods are well standardized, and those interested will find an abundance of literature on this phase of the subject.

THE NAGUILIAN CABLEWAY.

By FRANK T. JAMES, Assoc. Mem. Am. Soc. C. E.

The Bauang-Naguilian-Baguio Road has in its entire length of 50 kilometers (31 miles) but three rivers requiring bridges of any size, which crossings cannot be taken care of by temporary wooden structures. One of these—the Irisan—is bridged; another, the Ripsuan, when in flood remains at high stage but a short time compared to the third—the Naguilian.

The latter is 500 meters (approximately one third mile) between banks at the road crossing, rises to a height of 7.5 meters (approximately 25 feet) above low water in flood season and remains at this elevation sometimes 24 hours and does not recede to an elevation at which it is safe to cross on a raft or native boat, oftentimes for from three days to a week. It is therefore obvious that the value in rainy season of the whole Naguilian Road between its Bauang and Baguio terminals, is a question of the possibility of crossing this stream. To provide for this contingency an aerial tramway has been constructed and put in operation.

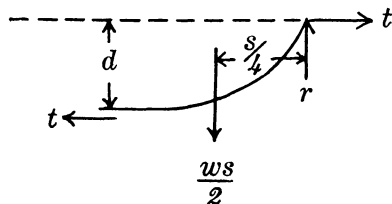
The system includes the following features: two shore towers, one on each bank, and a center tower on a concrete pier, over which the main and haulage cables pass; fixed anchorages on the west shore, a movable counterweight suspended from the east tower, and immediately back of it a windlass operated by carabaos; an open-frame car capable of accommodating comfortably six passengers and a conductor.

The principal factors entering into the design were that the cable at no time under full load should sag so that the car would hang within less than one-half meter of extreme high-water level; that the stress in the cable be practically constant; and that the center tower be able to satisfactorily and safely resist unusual strains due to unequal loads in the two spans.

The elevation of the bank on the west shore at Sta. Km. 17+390 is +6.40 meters; that on the east at Sta. Km. 17+890, +8.00 meters; the highest water known reached Elev. +7.50 meters. As constructed, the end towers at points of contact with cable are 537.5 meters (1,763.35 feet) apart. The center tower divides this span into two—one of 261.3 meters (857.28 feet) and one of 276.17 meters (906.07 feet).

The method of obtaining the height of towers necessary to obtain the desired clearance of the loaded car above high water may be of interest. In the design of the cableway, various considerations dictated that the towers be constructed of light-weight, but strong, material and be made as low as possible. Calculations showed that a dead load deflection of 2½ meters (8 feet) was satisfactory. It was decided, as above stated, that a clearance for the live load of one-half meter above maximum recorded flood levels was sufficient. In order to save time, it was deemed advisable to use a cable of a

diameter in stock in the Manila market. We were able to procure a 1½-inch plow steel cable, of 6 strands of 19 wires each, with an ultimate strength of 68 tons. Using a safety factor of 4, a working tension (t) of 17 tons (34,000 pounds) in the cable was allowed.



By taking moments about one tower (r), the following equation is derived, $td = \frac{ws}{2 \times 4}$

t =horizontal tension in cable, pounds

d =deflection in cable, feet

w =weight of cable, per foot (=2.45 pounds)

W =weight due live load, pounds

s =span in feet

r =supporting tower one end.

$$d = \frac{2.45 \times 906 \times 906}{2 \times 4 \times 34000} = 7.4 \text{ feet.}$$

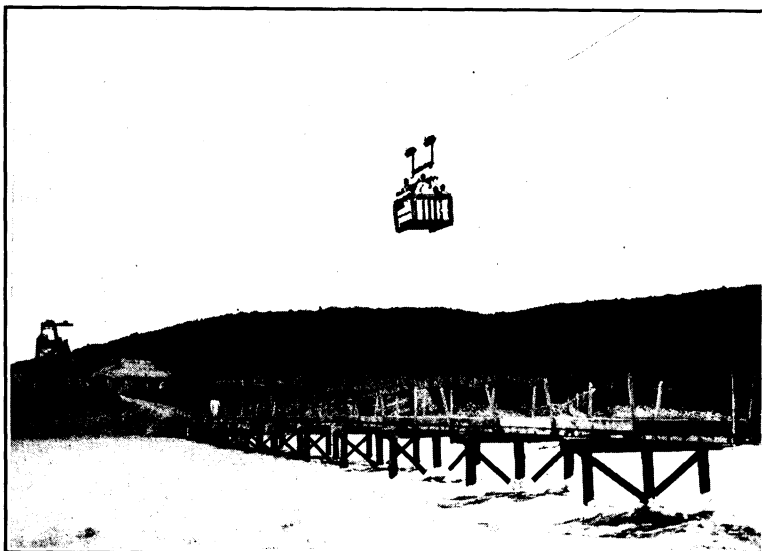


Plate I. Showing car over present channel, Naguilian River, Province of La Union.

We have thus kept within our limit of 8 feet sag for dead load. Considering the live load as made up of 1,150 pounds for the weight of trolley, carrier, and car, and 1,050 pounds for six passengers and conductor, we have a total live load of 2,200 pounds and the live load deflection at midspan would be

$$d = \frac{Ws}{2 \times 2 \times t} = \frac{2200 \times 906}{4 \times 34000} = 14.6 \text{ feet.}$$

The 17 tons tension in the cable could well be carried by the foundations available for the towers and it was decided to construct the towers of Oregon pine, and where necessary, of hard wood. The east shore tower was to support a 6-foot sheave over which the cable should pass to a 17-ton counterweight suspended a short distance above the ground and free to travel vertically, in order that the tension in the cable should always be, and never more than, the weight of the counterweight, though the sag due to the live load would vary from 0 at the tower to a maximum of 14.6 feet at midspan. Using the formula, $L = s \left(1 + \frac{8d^2}{3s^2}\right)$ for the length of cable under sag between supports, for the two values of d —7.4' and 14.6'—we get an increase in length of cable of 1.27 feet between towers when live load is at midspan—or in other words, inasmuch as the length of cable is fixed at the anchorages, the counter-

weight would move upward 1.27 feet while the car was traveling to center of the span, and back again to lowest position as the car proceeded to the further tower.

For the height of tower we figured from the water level upward thus:

	Meters.
Elevation of highest known water.....	7.50
Clearance to bottom of car.....	.50
Distance between bottom car to trolley.....	2.24
Sag due to live load, 14.6 feet.....	4.45
Sag due to weight of cable, 7.4 feet.....	2.25
Elevation required at supports, total.....	16.84

It was therefore decided to support the cable at approximately Elev. 17.00 meters.

A contract was let to local parties to build the two shore towers, the center pier, and center tower for ₱10,000 (\$5,000). A description of these structures follows.

The location of the center tower was fixed at Sta. Km. 17+615 because it was to be built on top of a concrete pier which would some day form one of eight piers for a steel-truss bridge which it is proposed to erect at this crossing in some future year and for which a profile with pier locations had been prepared. The best locations for the two shore towers were found to be approx. Sta.

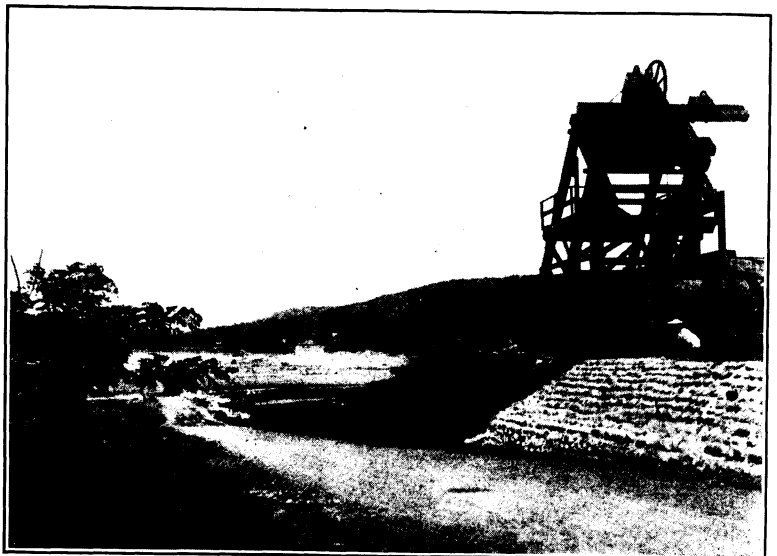


Plate II. Showing three towers and car.

Km. 17+351 on the west and Sta. Km. 17+888 on the east. See Plate No. II.

The west tower, nearest to the fixed anchorage (see Plate III) is constructed such that the median line between its supporting posts shall bisect the angle which the cable makes when crossing the saddle on top of the tower. Hence the necessarily vertical posts taking the weight, and the inclined posts for stability against overturning due to stress in the cable. On the east tower (see Plate IV) however the design is such that the main member takes practically all the stress—the resultant of the stress in the cable on both sides of the large sheave where the forces are approximately at right angles to each other, the resultant being at nearly 45° to the vertical.

West tower.—The four posts, for about half their lengths are of ipil—a very hard native wood which resists weathering quite successfully—and of Oregon pine for the remaining distance to the top stringer, likewise pine. All are 12 by 12 inches in section. The posts are set on concrete bases and bolted to hooked straps imbedded about 75 centimeters (2½ feet) in the concrete. The bases extend about a meter into the ground. The posts are liberally cross-braced, ¾-inch bolts being used throughout. The two stringers with a separator, bind the posts together, being bolted through with 1-inch round bolts. On the ends of the stringers, which are cantilevered upstream, a sheave is bolted for the return haulage cable.

The landing platform is constructed 3.25 meters (10 feet) below the cable—about 60 centimeters (2 feet) below the bottom of the

car when empty at this point. Stairs lead from the ground to the landing.

Center pier and tower.—It would have been difficult to build any sort of wooden structure to serve as a tower in the center of the Naguilian River, which would have successfully resisted the buffeting of the large amounts of drift and great scouring action, accompanying the floods every typhoon season—that is, for any length of time—unless it were a very elaborate and expensive affair and subject to renewal, in a large measure, every season at an unwarranted cost. The present system is of a temporary nature at best, but as far as the shore towers are concerned, they will last as long as the timber is in even fair condition and kept painted—perhaps more than five years—for they are subject only to weather conditions and not to the action of the river, and are considerable distance back from the banks subject to scour. Furthermore, if the necessity arose, the Oregon pine timber could be replaced with hard wood and the towers

centimeters (2 feet) below low water and it has never been known to be much more than this save in a pool or two near the east bank some years ago, and long since filled up by subsequent floods.

It was deemed, therefore, that Elev. -2.00 meters would be a proper depth for the location of the base of the footing, which should rest on piles to be driven at least 4.88 meters (16 feet) below this elevation. Thus, with approximately one meter clearance of the bridge seat above high water the top of the concrete would be Elev. $+8.50$, and the pier would be 10.50 meters (approximately 34½ feet) high from bottom of footing. Accordingly the pier was designed and built with the footing 10.06 by 3.86 meters (33 feet by 12 feet 8 inches) and 1.50 meters (5 feet) thick on 70 wooden piles driven to a bearing of 11 tons or better. The pier proper was built set in approximately 60 centimeters (2 feet) from the top edge of the footing longitudinally and 20 centimeters (8 inches) at the ends, faces battered 1:20 to the bottom of the bridge seat.

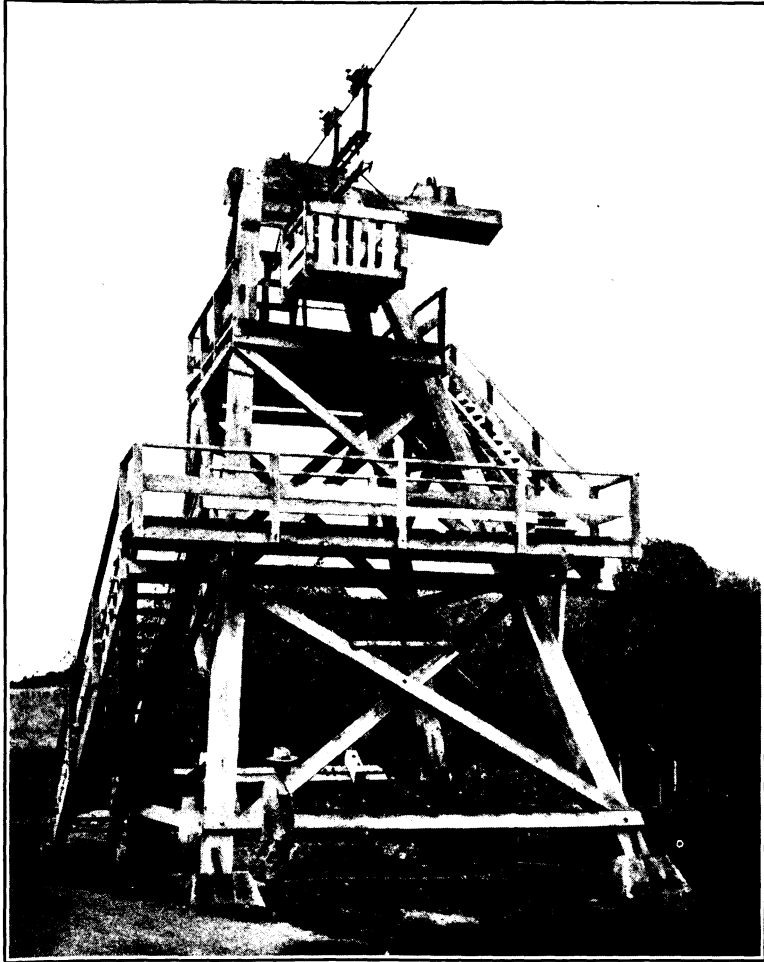


Plate III. West shore tower and haulage cable anchorage.

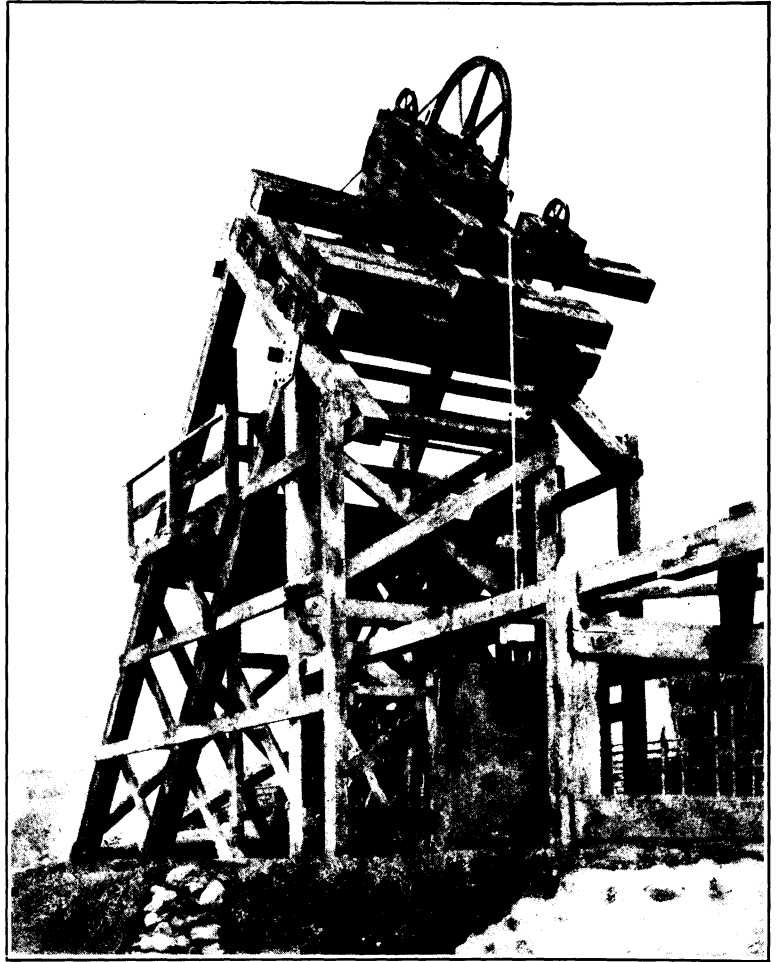


Plate IV. East shore tower with counterweight.

made permanent. This reasoning does not hold, of course, for the center tower and the value (durability) of the shore towers seems to warrant an equally permanent structure at the critical point of the system. Adding to this the probability of constructing a steel truss bridge here at some future date—for communication with Baguio *must* be maintained in event of serious damage to the Benguet Road—the decision to construct a concrete foundation for the center tower is amply justified.

The subsoil conditions existing in this river, as in practically all of the streams on the northwest coast of Luzon, consist of large hard boulders, coarse gravel and some clay, overlaid with sand varying from coarse to silt.

Each year the channel of the river moves one way or the other, often times in the same direction for consecutive years, scouring out the finer material and disclosing boulders. Strangely, though, the present deepest section in the whole width of the river is only 60

Some difficulty was experienced in making the excavation for this pier and preparing to drive the piles. The elevation of the ground at the site was approximately 4.50 meters (15 feet) above low water 0.00, and the material to this latter elevation was sand, small gravel and boulders, in other words, material which stood at a very flat angle of repose on excavation. The sheet piling, as originally driven before the writer had supervision of the project, was not along lines sufficiently wide to allow for any possible movement inward due to the high banks of material behind it, and when excavation had reached about Elev. -1.00 meters the neat lines were not as shown on plans. When finished driving the second time, the sheet piling was more than half a meter (approximately 2 feet) outside of neat lines practically to the full depth of the excavation for the footing. When the excavation had reach approximately Elev. -1.50 meters, piles ranging in length from 8 to 10 meters were driven on centers of approximately one meter both longitudinally and transversely, staggered.

The excavation was then completed to grade—Elev. -2.00 meters—and the piles cut off at -1.70 meters. With an 8 by 6 inch Gould centrifugal pump, the suction lift being 18 feet, we had pumped out the pit to within 60 centimeters (2 feet) of the bottom, so it was necessary to place the very bottom concrete under water. Therefore, with a *tremie* measuring 10 by 10 inches inside, hand mixed concrete $1:2\frac{1}{2}:5$ mixture, was placed to a height of 50 centimeters (1 foot 8 inches) over the full width and length of the pit (no forms were yet placed) to both thoroughly seal the bottom and sides, and make a monolithic mass of concrete between the two long sides of sheet piling, thus preventing any caving-in when the lower braces should be taken out to permit of placing forms and concrete. No pumping was done while sealing the bottom under the 2 meters of water, for fear of drawing off part of the cement in the concrete, though mixed dry.

When the 50 centimeters layer of concrete had set 24 hours, the pit was pumped out to below the top of this layer, forms placed to lines as per plan for the remaining meter of thickness and concrete— $1:3:6$ mixture—placed dry to Elev. -0.50 meters. The lower bracing for the sheet piling was at approximately Elev. 0.00 and in five lines. All but one line—near the center—were cut out and forms for the pier proper placed up to this one. After concrete had been brought to this height and had set, the forms were stripped, blocking placed just under the center brace, between the concrete and the waling strips on both sides, securely wedged, and the brace knocked out. The sheet piling, held on the bottom by the monolithic base, and the top bracing at Elev. $+2.00$ meters, showed a movement of only about 5 centimeters (2 inches) in one or two places along the level of the lower waling strips. When the concrete reached the top bracing, the latter was knocked out and the sheet piling came in but slightly in spite of the weight of material behind it, probably due to the rigidity of its lower ends. The placing of concrete for the rest of the pier then proceeded rapidly.

The sheet piling was not drawn, and, as an added security against much dangerous scouring around the piles in any future tremendous flood, boulders were placed to Elev. $+2.00$ meters in the space between the sheet piling and concrete pier. Then backfill was continued with sand and gravel to restore the general level at the site—Elev. $+4.50$ meters.

The tower set on top of this pier is shown in Plate V. The posts are 8 by 8 inch Oregon pine and are bolted to steel straps $\frac{1}{2}$ by 3 inches by 4 feet 7 inches set 60 centimeters (2 feet) into the concrete. The ends of the straps are bent about 2 inches at right angles to form a sort of hook.

The main cable ($1\frac{1}{4}$ inch) is supported in a saddle 60 centimeters (2 feet) long, of semisteel, which in turn is carried by two cantilevers supported additionally by two $\frac{3}{8}$ -inch rods tying together bearing plates on the top stringers and underneath the cantilevers. Plate V shows the carrier trolley just passing the saddle, the cantilever arms, and the tie rods.

East tower—Plates II and IV show this structure well. The height from sills to bearing blocks for large sheave is 7.92 meters (26 feet), length from end to end of sills 10.36 meters (34 feet) and width out to out of 12 by 12 inch posts 3.40 meters (12 feet 2 inches). Three fourths-inch steel plates are securely bolted on both sides of the joints where the 12 inch by 12 inch main struts, 12 by 16 inch stringers, and posts come together.

The sills are 12 by 12 inches and of ipil. They are dapped one inch where the four struts are strapped to them, and between these points rest on, and are anchored to, a concrete base T-shaped, 30 centimeters (12 inches) wide under the sills and 25 centimeters (10 inches) across the front, but tapering in depth from 20 centimeters (8 inches) under the inside strut to 1.00 meter (3 feet $3\frac{1}{4}$ inches) under the end of the outer one. The base is reinforced with $\frac{3}{4}$ -inch square twisted steel bars both horizontally and vertically. This base distributes the stress of 24 tons in the struts, which must be resisted by the ground in the bank.

The bracing between the main members is 3 by 8 inches, liberally placed, and fastened with $\frac{3}{4}$ -inch steel bolts. On the far side of the tower stairs lead from the ground to the landing platform which is somewhat lower than the bottom of the car.

Plate VI shows well the arrangement of the sheave for the main

cable, the small sheave for the haulage cable and the 17-ton counterweight with socket attachment partially in view.

The counterweight.—This feature of the system, shown in Plate IV, consists of a plain concrete cylinder 1.88 meters diameter and 2.50 meters high (6 feet 2 inches by 8 feet 2 inches) with four $1\frac{1}{4}$ -inch round rods 3.43 meters long (11 feet 3 inches) and 7 inches on center, hooked around four 1-inch square bars 4 feet long at a height of about 6 inches above the bottom, and extending up through the middle of it, and outside 66 centimeters (2 feet 2 inches) with the ends threaded 18 inches for socket attachment. The concrete is of a $1:2\frac{1}{2}:5$ mixture, contains approximately 6.4 cubic meters (8.37 cubic yards) weighing approximately 34,000 pounds (17 tons). To provide for a possible necessity of increasing the weight of the counterweight (should the cable stretch and cause too great a sag at midspan) it was constructed with an annular valley 60 centimeters (2 feet) deep,



Plate V. Center pier and tower.

outside diameter 1.20 meters (4 feet), and inside diameter 50 centimeters (20 inches). This may be filled with gravel or sand and give approximately 0.60 cubic meter more volume or approximately 1 ton more weight. The valley is provided with a drain for rainwater.

Windlass.—A glance at Plate No. VI will facilitate a thorough understanding of its construction and operation. The base consists of six (ipil) blocks 12 by 12 inches by 6 feet, set 60° apart along the circumference of a circle 5.70 meters in diameter, tangent to same at their centers, at the same elevation as the bottom of the (ipil) sills of the east tower. On top of each 6-foot base at the two outer quarter-points are placed two more blocks, likewise ipil, 12 by 12 inches by 1 foot 6 inches, long edges parallel. Across the top of adjacent blocks not on the same base, are placed 6 beams—4 by 12 inches by 11 feet flat, with ends butting, a drift bolt $\frac{3}{4}$ -inch by 28 inches being driven through beam, block and base.

Halfway between supports, on each beam is a molave (native hardwood) roller 5 inches long and tapered from a diameter of 5 inches at

the inner end to 5½ inches at the outer end, carried on a ¾-inch round pin, in turn carried on molave supports 3 by 6 inches by 1 foot 6 inches long, fastened to the beam with ¾-inch bolts.

The drum, or wheel, consists of three layers of Oregon pine boards. The upper and lower are 3 by 12 inches at right angles to each other, cut to a circle of 3.35 meters (11 feet), radius and the middle layer 2 by 12 inches cut 5 centimeters (2 inches) shorter around the circumference, the three layers liberally tied together with ¾-inch bolts. The adjacent edges of the 3 by 12 inches are beveled to form a smooth groove for the cable. Bolted through on top and bottom at the center of the wheel are four pieces of 4 by 12 inch by 4 foot cleats, also at right angles to the adjacent layers, to add stiffness to the wheel and increase the length of bearing surface on the pivot.

On the underneath face of the wheel near the outer edge are 4 by 6 inch blocks, fastened with ½-inch bolts, to which are nailed 2 by 12 inch runners which support the wheel on the rollers. Two of these 4 by 6 inch pieces are 14 feet long and are seen extending outside the drum for attaching traces for operation by carabaos. The wheel is further supported at its center by a hardwood pivot, of ipil. This pivot is round in section, diameter 12 inches, to a height of 9 inches and tapers through 17 more to a diameter of 9 inches, then is offset 1 inch all around and extends 12 inches higher at a constant diameter of 7 inches. On the bottom of the pivot is a bearing plate 9 by 9

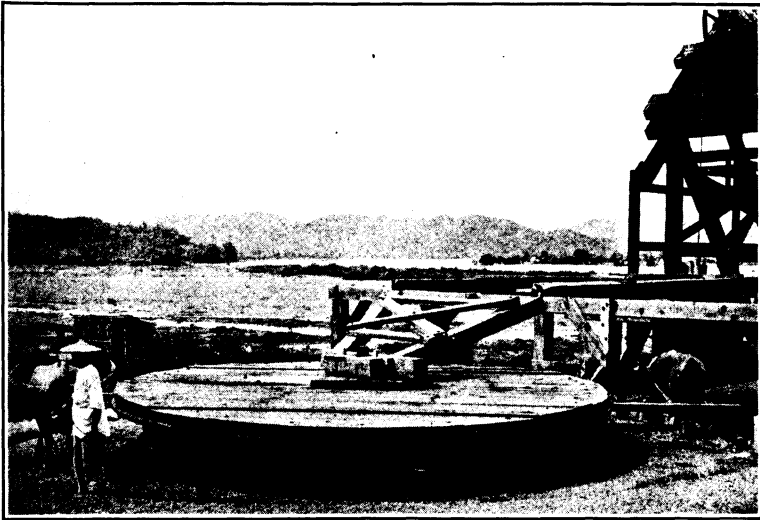


Plate VI. Windlass.

inches by ¾ inch fastened with lagscrews, which bears at its center, on a hemispherical bearing plate set into a concrete base 90 by 90 by 80 centimeters high (3 by 3 feet by 2 feet 8 inches) and held firmly with bolts. The pivot is held in a perpendicular position at the lower end by hardwood blocks 10 by 10 inches by 4 feet and fillers 8 by 10 by 18 inches firmly anchored to the concrete, fitted with wedges for taking up shrinkage due to wet weather, and on the top—the 7-inch section—by a similar hardwood bearing shown well in Plate No. VI. To counteract the pull in the haulage cable when in operation the upper bearing is braced against the beam shown in the same plate, the beam itself being braced against the tower as shown. The beam carries also the sheave block for the windlass sheaves.

Anchorage.—The cable is fastened on the west shore to a fixed anchorage. (See Plate VII.) The lower end of the eyebar (4 inches by 1 inch, 26 feet long) of medium open-hearth steel, carries a steel pin, 3¼ inches by 2 feet, supporting a grillage of 1½-inch square twisted hooked bars and stirrups about 4 feet long, all imbedded in a block of concrete—1: 2: 4 mixture, 1.50 by 1.30 by 2.30 meters (6 feet by 4 feet 3 inches by 7 feet 6 inches) weighing about 9 tons.

The base of the concrete is at Elev. +3.40 meters, or about 3 meters below the general elevation of the ground in the vicinity of the west tower, and the face is 22 meters (72 feet 2 inches) back of the vertical legs of the tower. Before the backfill was placed, the space between the tower face of the anchorage and the bank was carefully filled with concrete 1: 3: 6 mixture, with "plums," to full height (2.30

meters) to insure absolutely no sliding movement, later, of the anchorage when under load from the cable.

The eyebar was painted with asphalt, burlap wrapped around it, and then painted with a second coat of asphalt, over the length exposed to air and that in the ground close up to the face of the concrete.

Through the exposed end of the eyebar is another 3¼-inch pin to which, with separators, are attached the eyebolts (1½ inches by 5 feet) which in turn carry the socket with cable. (See Plate VIII.)

Metal fittings.—With the exception of the large and small sheaves, all of the fittings used in connection with the 1¼-inch main cable are semisteel castings containing 40 per cent of steel and 60 per cent cast iron. Included in these are the two sockets, the west tower

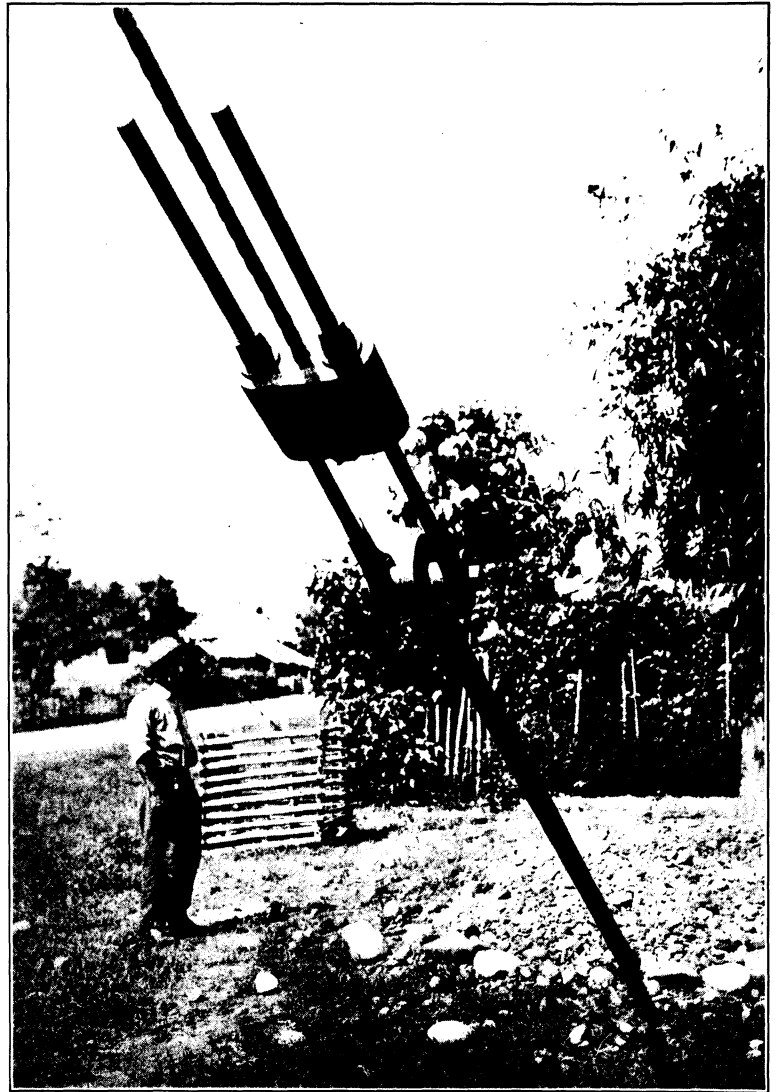


Plate VII. Anchorage, west shore.

saddle, center saddle and haulage cable roller and, in part, the trolley carrier.

The main plates, suspenders and connections on the carrier are of medium open-hearth steel, likewise the straps on the car while the large and small sheaves are wholly cast iron.

Car.—The car is a simple frame, of light lumber, 5 feet by 4 feet 8 inches by 3 feet 4 inches, bolted and nailed. It weighs, with the end straps, approximately 400 pounds.

Cable socket attachments.—This was probably the most difficult and by far, the most important, part of the construction of the cableway. The procedure was as follows: (See Plates VII and VIII.)

The cable was hauled out along the road on the west side of the river and all of the twist and turns taken out—the cable was not supplied on a reel, but in three coils—two splices 50 feet long made by

an expert in the business, and then the required length between socket faces—560.35 meters (1,838 feet 5 inches)—carefully measured with a 20-meter tape, and checked twice. To this length was added 25 centimeters (10 inches) twice for length of sockets, and 18 centimeters (7 inches) twice for turning back of the wires into the core of the socket. A fine wire was then firmly wound around the cable at two points this total distance apart, 560.99 meters (1,840 feet 8 inches) and the strands cut one by one. The cable was next hauled across the river passing through the centre tower.

The sockets were then prepared to receive the cable. A glance at Plate VIII shows well the socket for the west anchorage. It is 5½ by 12 inches in section and 10 inches long, carrying two holes tapering from a diameter of 2½ inches to a diameter of 1½ inches away

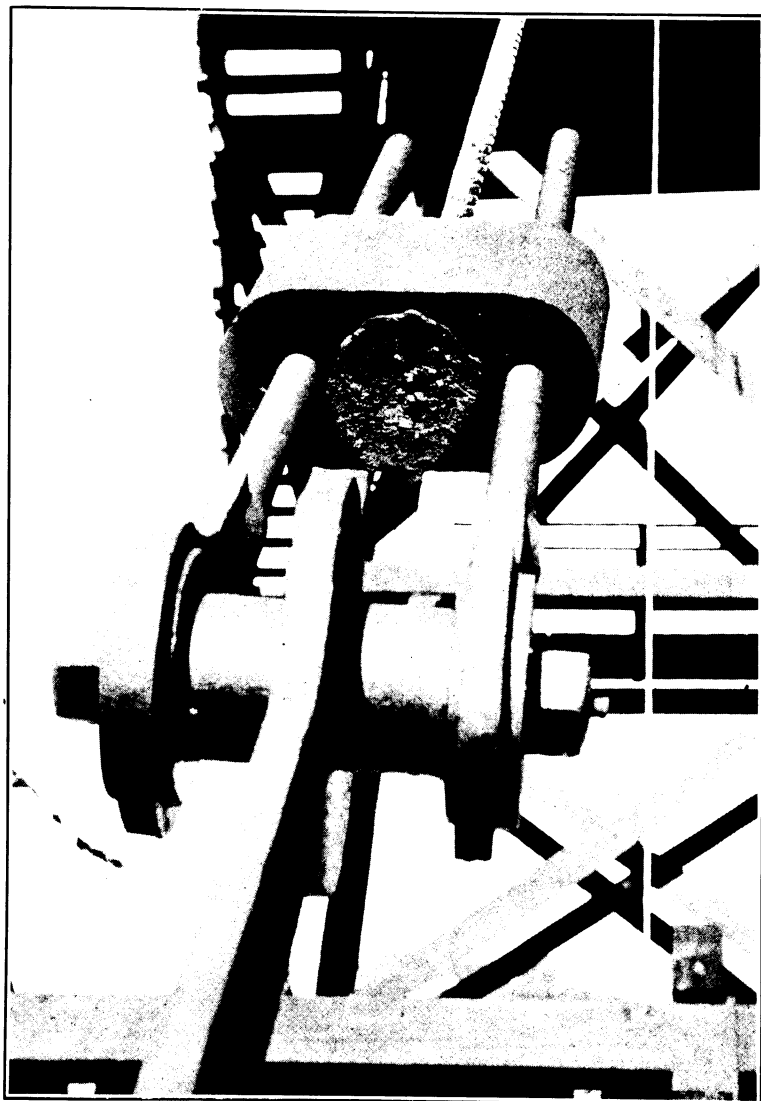


Plate VIII. West socket (Naguillian cable crossing).

from the anchorage. The diameter of the eye bolts is 1½ inches. The core in the center of the socket to receive the cable is tapered in the same direction from a diameter of 3½ inches to a diameter of 1¼ inches. The surface of the core is roughened.

The large socket for the attachment to the counterweight rods is 12 by 12 inches in section, 10 inches long and carries 4 holes 7 inches c to c, tapered from a diameter of 2½ inches nearest the counterweight to a diameter of 1½ inches on top. The core is the same as in west shore socket.

The preparation mentioned above consisted of thoroughly scraping and cleaning the sockets of all dirt and scale, filing the small diameter of the core to slightly more than 1¼ inches and then finally cleansing the whole piece of metal with gasoline, then muriatic acid and rinsing the acid off with a scalding hot solution of caustic soda and water.

Before inserting the cable into the socket it was cleaned with a bath of gasoline for a distance of about one meter from its end.

Around the two points on the cable determining the effective length of same, fine wires as indices had been wound a few turns, and for ease in manipulating the strands and wires in making the attachment, the cable by gentle turning, was forced through the 1¼-inch end of the core to about half a meter beyond this point. The separate strands were then unlayed up to within about 3 centimeters (1¼ inches) of the index and the hemp center cut out, the strands then broomed out, the wires cut off in short lengths ranging from 0 to 3 centimeters and scraped bright with emery paper, then heated with a blowtorch at the point 7 inches from the end.

As shown in Plate IX the individual wires were bent back and inside while still hot, or annealed, care being taken to do no injury to them. The cable end—all that was to subsequently enter the core of the socket—was then treated as the socket had been, the bath of gasoline to take off any dirt and soot from the torch, the muriatic acid to leave a rough surface on each wire, and the soda solution to neutralize any acid remaining. In addition to this, the cable-end was given a bath of plain hot water. The cable was then pulled back into the socket until the bends in the wires were even with the top face.

In the meantime, zinc was being heated in a melting pot. The socket was then placed on top of a cement barrel filled with clay, with the prepared cable-end and large end of core, up, and the clay well tamped around the lower, or small, end of the core to make a dam to hold in the metal about to be poured. A dam was placed on top of the socket and around the core about 1 inch greater in diameter.

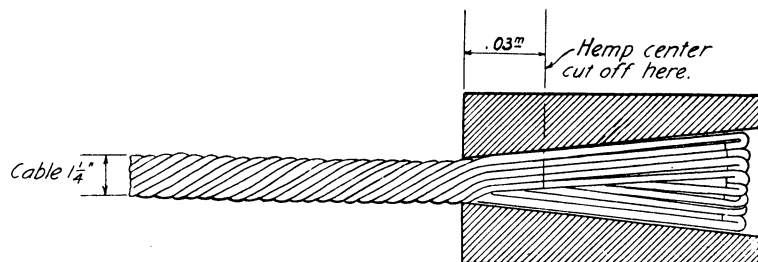


Plate IX. Section through cable socket showing method of fastening cable, Naguillian River cableway, Province of La Union.

When the zinc was wholly melted it was immediately poured into the core of the socket and around the wires until wholly filled and covering the top of the wires, flowing out into a lake inside the dam.

Plate No. VIII, the west shore socket, admirably shows the results obtained.

Erection.—As indicated in the erection diagram and shown in Plate No. X the counterweight was cast in position, top at Elev. +13.20 meters on a crib of 12 by 12 inches Oregon pine timbers, each layer arranged carefully with regard to locating hydraulic jacks subsequently for lowering the weight. After the sockets had been attached to the cable, the east socket was fastened to the rods in the counterweight by means of double nuts, screwed up against the bearing washer just enough (about 4 inches) to utilize all the thread in the nuts.

On the west shore the eyebolts were attached to the anchor eyebar, the threads well oiled, and the double nuts from each bolt taken off and put on a bench a little distance away, and designated as fitting the north or south bolt, as it was anticipated that we should have to work fast when ultimately sliding the socket into place. The grooves in the large sheave (east tower) and centre and west tower saddles were well lubricated with ordinary axle grease, the cable hoisted from its temporary resting place on the lower struts of the pier tower, up into the saddle, and then further lubricated on its under side for some distance beyond (east) where it entered the sheave and saddles. Between the towers and the centre pier the cable lay on the ground for practically two thirds of the distance.

The apparatus for swinging the cable into final position was arranged and applied as follows:

Behind the concrete anchorage on the west shore, and bearing against it, a timber 12 by 16 inches 15 feet long was placed, vertically,

10 feet into the ground and the earth tamped thoroughly. Around this "deadman" were wound three full turns of spare 1½-inch wire cable in a diameter of about 4 feet, ends firmly bound together with small wire, into which loop the hook of a double 24-inch diamond sheave was slipped and caught-over with lashings.

Onto the main cable beginning about 20 feet above the face of the socket, a loop 15 feet long was tied. It consisted of two separate lines of hemp rope, 3 inches diameter, lashed to the cable by means of unlaying the strands for about 4 feet, carefully and tightly winding and knotting them, sailor fashion, around the cable at varying distances from the end of the unlaying, and with smaller pieces of rope lashing all ends securely.

Through this double-line loop the hook of a triple 24-inch diamond sheave was slipped and lashed. A 300-foot length of ¾-inch plow steel hoisting cable was run through the two sheaves, one end clamped to the becket in the one at the "deadman," and the other free for attaching to the power unit.

When the apparatus was all ready, a man with a can of axle grease was sent up on top of the west tower and one up the pier tower with instructions to keep the under side of the cable greased as it entered the saddle.

The free end of the hoisting cable was then made fast to the axle of a 40-horsepower 2½-ton automobile truck. As this moved slowly down the road—parallel and very near to the axial line of the cable—under low-gear the slack in the main cable began to decrease rapidly compared to the distance travelled by the socket, which was about 10 meters (approximately 33 feet) from the end of the eyebolt in the anchorage, before operations began. As the cable swung free from the river bed in the two spans (almost simultaneously) the stress in the cable increased very rapidly and the chauffeur of the truck had to gradually increase his power to very near the maximum to proceed further. As the socket approached to within a very short distance of the eyebolts the pull in the cable was greater than the tractive effort of the truck which was loaded with about one ton of freight, distributed over the platform. By putting chains on the rear wheels and concentrating the load directly over them, then opening the throttle to full admission of gasoline we very, very slowly took up more of the sag in the cable until the tractive effort was again too small and the truck refused to budge further.

During this last operation, from time to time, trials were made to see if the socket was near enough to slip onto the bolts, each time resulting in no success, until at the very last gasp of the engine and the squeaking of the brakes applied to their utmost capacity to hold what advantage we had gained, the socket swung into a position permitting the bolts to pass through the holes and outside barely the length of one nut. The washers and nuts were immediately screwed into place and turned with long-handled wrenches. As we took up a little thread with the nuts, the truck was able to move a little more, thus relieving slightly the stress on the nuts. Thus the nuts were turned up until more than half of the eyebolts extended outside of the socket, and then the hauling line was slackened off, gradually, until the anchorage took all the strain in the cable. It had taken about four hours from the time when the "deadman" was set in place.

At the very beginning of this erection operation the stress in the cable was little more than the weight of the cable, about 2½ tons, but as the cable was lifted from the ground and the sag taken out of it, the stress increased until at the time of fastening the socket, it was nearly 4½ tons. With the cable in this position—counterweight still supported with top at Elev. +13.20 feet—the elevation of the bottom of the cable in the west span was +9.31 meters and in the east span +8.44 m.

Plate No. X shows the method of procedure from this point. On the inner pieces of 12 by 12 inches were four 60-ton hydraulic jacks, one at each corner. By raising the weight a little and taking out one line of 12 by 12 inches and inserting three pieces of blocking of 4-inch stuff at each corner, the counterweight was lowered through 12 inches in stages of 4 inches, two adjacent jacks released at one time. Then while the weight was supported wholly on the jacks, the next line of 12 by 12 inches was replaced by blocking, and the operation above repeated.

When the top of the counterweight had been lowered to approximately Elev. +11.38 m. the car was loaded with boulders to about 3,000 pounds gross weight and run out to the middle of the east span. This did not lift the weight from the jacks, and so, as it was thought advisable not to dig a very deep hole under the tower at this point—the bottoms of the jacks were now at Elev. +7.50 feet somewhat below the sills—and as up to the moment of lifting the weight clear the stress in the cable could never be more than the weight of the counterweight itself, no matter how much load was placed at midspan, the load in the car was gradually increased until it was approximately 7,000 pounds gross weight, and the counterweight lifted about one centimeter (half an inch). The blocking and jacks were immediately taken out from under the counterweight.



Plate X. Counterweight on crib.

the load in the car gradually reduced to the weight of the car alone, the weight slowly settling to Elev +10.75 meters and the cable in the east span rising to Elev. +14.05 meters. When the car was brought back to the platform at the east tower the weight settled to Elev. +10.61 meters, and the cable at midspan rested at Elev. +14.49 meters. Twenty-four hours later the weight had settled 3 centimeters and the cable risen to Elev. 14.53 meters.

Two days later the counterweight was overloaded by 5 tons—to 22 tons total weight—and then it settled 15 centimeters (6 inches) more. The overload was later removed.

One month later, the system not yet used save for trial operations, the cable had stretched so that the following elevations obtained:

	Meters.
Elevation top of counterweight.....	+9.96
Elevation cable midspan—east.....	+14.58
Elevation cable midspan—west.....	+14.92

The haulage cable was erected as per erectors notice on Plate XI.

Plate III shows the west anchorage where the cable passes down from the return sheave on the tower through two sheaves at the same level and up onto the haulage sheave on the west tower.

Operation.—As shown in Plate VI the windlass is turned by harnessing two carabaos to the arms extending outside of the wheel and opposite each other. If the wheel is turned in the direction in which the animals are shown the car will move from west to east. The stress in the haulage cable— $\frac{3}{8}$ -inch plow steel—under the load of seven persons in the car is a maximum at 1,020 pounds. Two carabaos

rator between the hooks. A slight pull on the ropes will raise the hooks from the working position.

It will be further noted from this picture that if the trolley jumped from the cable towards the right, the suspenders would still hold it against the cable, while if it jumped to the left the main plates, which extend down one inch below the rollers, would hold it.

Plate I shows the car in the middle of the west span and over the present channel in the Naguilian River. The water would need rise only 1.50 meters (5 feet) more to float the floor of the bridge to the bank, and it could rise nearly 5 meters (approximately 16

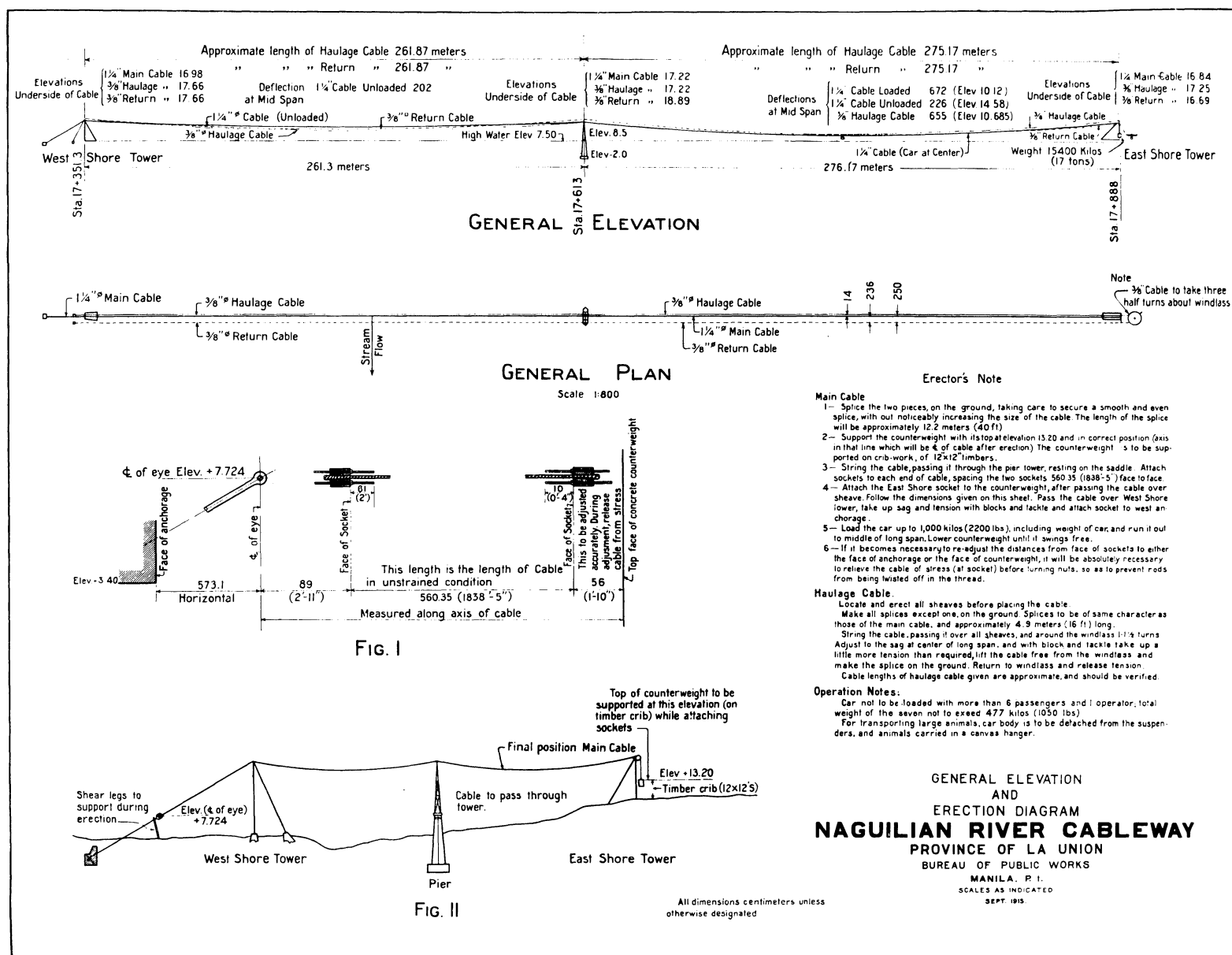


PLATE XI

are used as the operation is a little difficult for one, especially in starting.

Plate No. XII shows the method of attaching the trolley to the haulage cable—by means of the two clamps with set screws, which can be released quickly if by any chance when nearing the towers, the windlass operator fails to act promptly upon receiving the signals to stop from the tower man, and the car proceeds to butt up into the tower. The hooks extending out, like arms, at each end of the separator bar, just above the end straps are for catching onto an attachment on the tower, to hold the car still while passengers are boarding or alighting and to give absolute control to the conductor. The ropes in the hands of the conductor should properly pass through awning pulleys bolted to the suspenders and then down into the sepa-

feet) more without endangering the lives of passengers in the car. Thus far this year, October 1, the water has not risen to within a foot of the floor and the system, finished July 31, has not been called upon.

For a system of signalling across the river, a telephone line has been installed between the towers with the wires passing outside and above the haulage cable upstream. A wall telephone, magneto-bridging type, is located in small houses near both the east and west towers and outside, on the towers, up near the platform, is located a No. 6 gong, loud sounding, for emergency signalling.

The cost of metal fittings, location of same, construction of counterweight, anchorage, and windlass, including cost of materials erection of cable and miscellaneous labor, inspection, etc., was ₱6,284. The

total cost, including the contract price of ₱10,000 for the three towers and piers, was therefore ₱16,284 (\$8,142 U. S. currency).

The writer acted in the capacity of supervising engineer during the construction of the center pier, windlass, counterweight and an-

estuaries are numerous. Two-thirds of the towns of the province nestle on the banks—"pampang" (dikes)—of navigable rivers. On seeing the great number of dikes in Pampanga one need not wonder why this name was chosen for the province.

HISTORICAL.

The Province of Pampanga formerly extended into the present Province of Tarlac and the inhabitants of the southern half of that province belong to the Pampanga tribe and speak the Pampanga dialect. There are approximately 400,000 Filipinos who speak Pampango, of which 248,000 reside in the province. The area of Pampanga Province as now defined is 868 square miles. The assessed

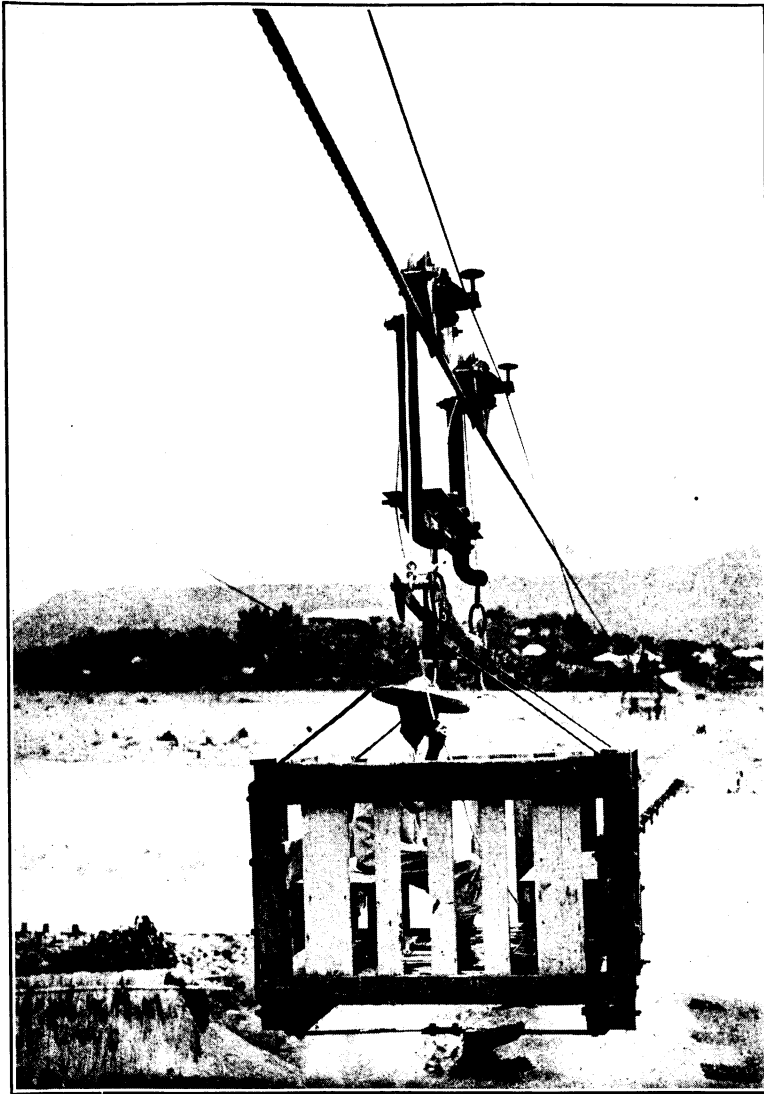


Plate XII. Trolley, suspenders, and car.

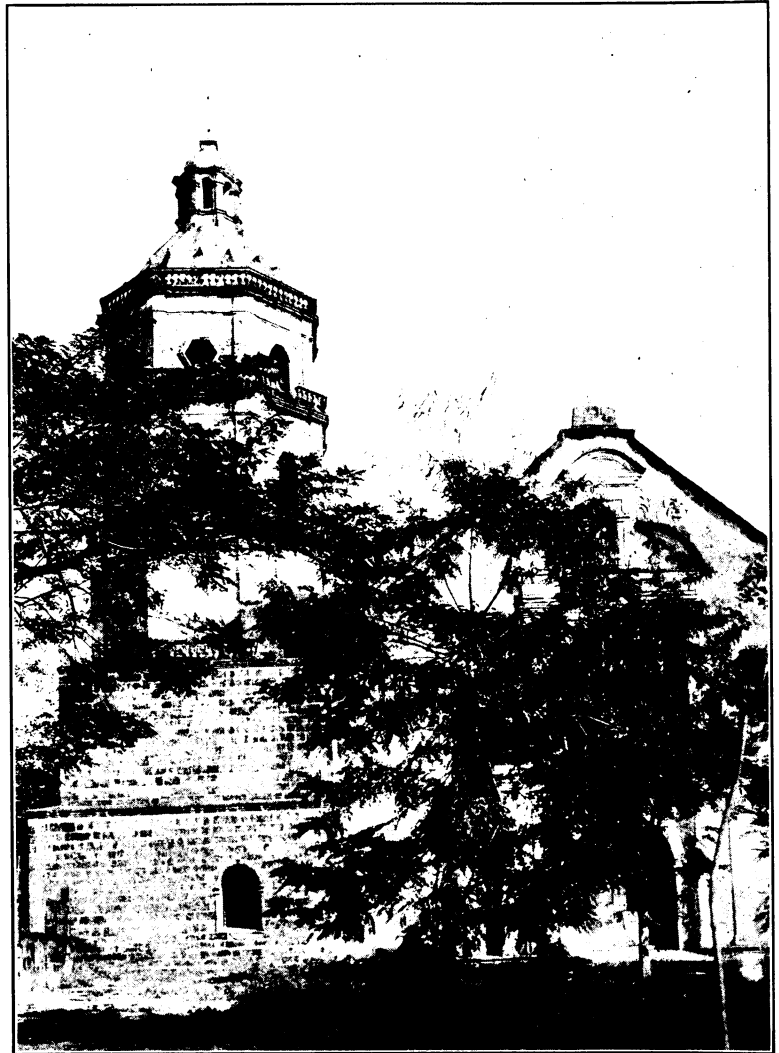
chorage, and the erection of the cables. The district engineer of La Union was in immediate charge, and Mr. H. C. Craig, district superintendent artesian-well division, Bureau of Public Works, did all the splicing of cables and preparation of same for bonding to the sockets.

PAMPANGA, PAST AND PRESENT.

By E. J. HALSEMA, District Engineer.

One of the richest, most prosperous and best situated provinces in the Philippine Islands is located but a short distance northwest of Manila. San Fernando, the capital of the province is but two and one-half hours run or 37 miles on the main railroad extending north from Manila. With but two hours run by automobile, on the first-class roads extending through Rizal, Bulacan and Pampanga provinces the distance is 42 miles. The fifteenth degree latitude north and 120.5 degree longitude east cut the province in four parts.

The southern portion of the province is swampy and of delta formation and contains many fisheries. The central portion is from 3 to 5 meters above sea level. Further north there is a gradual rise, scarcely noticeable. To the west lie the mountains of Zambales, while in the northeast corner, magnificent Mount Arayat, an extinct volcano, towers over 3,000 feet from the plain below. Rivers and



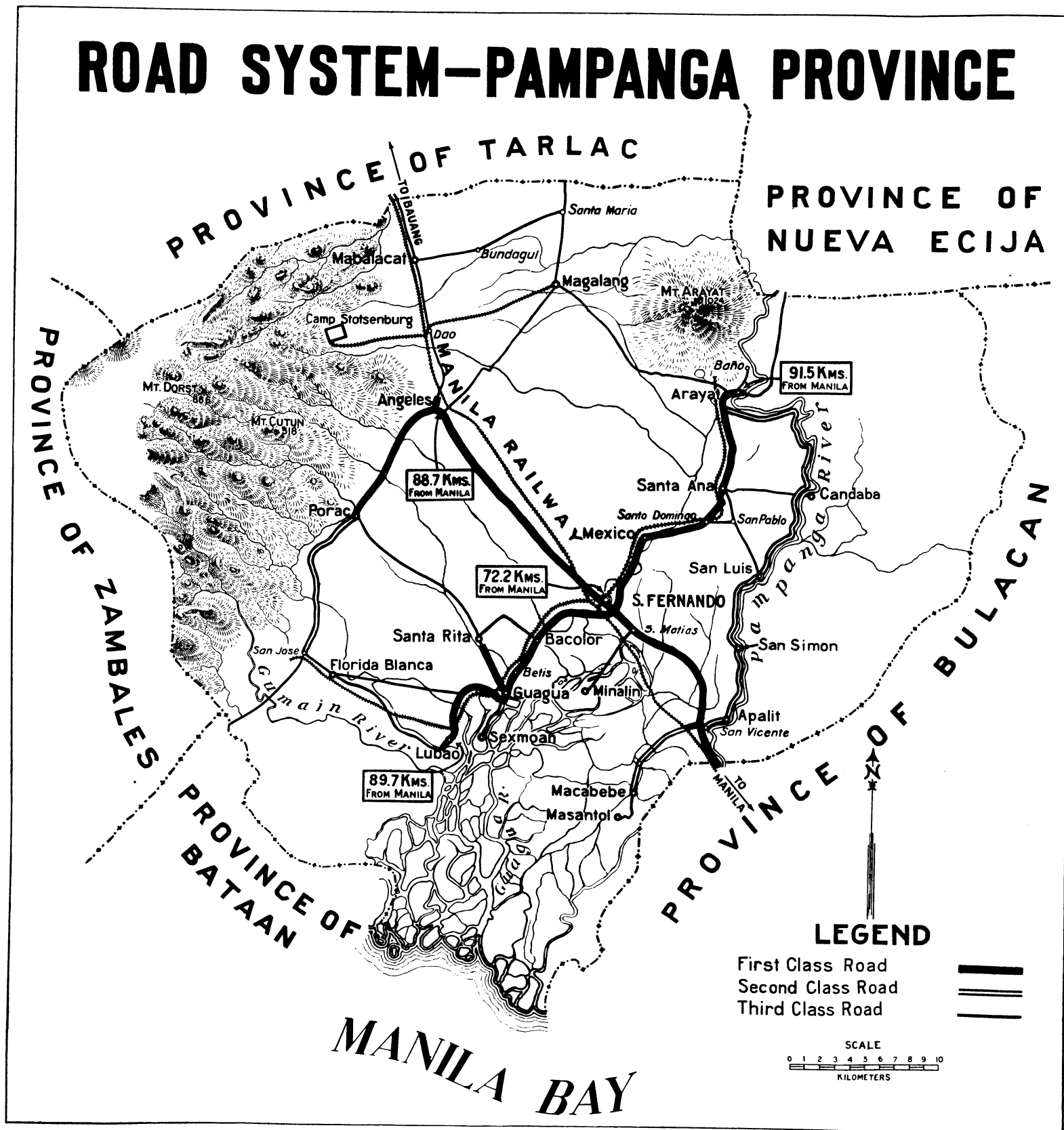
Lubao Church, built in 1572 by the Agustinian Order. This was the first church in Pampanga.

taxable valuation is ₱20,000,000. Government and other property not taxable is valued at ₱3,500,000.

The first settlements of Pampanga were made in Lubao and Betis, the latter now a barrio of Guagua, and established by the Augustinian Order in the year 1572. Parts of the church in Lubao are nearly three and one-half centuries old. Before the close of the sixteenth century (1596) no less than eleven towns were established in the province. The entire province was administered by this order and their parish priests were responsible for the making of roads and bridges from town to town. The roads constructed were along the dikes, or "pampang," of the rivers as was customary, and were usually tortuous and serpentine in course. They were impassable during the rainy season and the people were required to abandon the "pampang" or dike for the stream, as the only line of communication left available. These tortuous "pampang" roads gradually gave place to shorter and

straighter road routes. Two examples are still visible in the province, one between San Fernando and Bacolor, and the other between San Fernando and Mexico. The only surfaced road in the province was

rendered splendid service in the development of the province. Steamboats from Manila called at three of the towns and large cascos, propelled by sails or man power, furnish transportation facilities to most



between San Fernando and Bacolor, the capital at that time. This was constructed to connect with the railroad station about 1891. One main highway extended through the province toward Dagupan from Manila and this was passable during dry season only.

Notwithstanding, this deficiency in road construction the streams

of the others. Some towns were able to transport their products over sandy roads to the ports the greater part of the year. Large and substantial churches were constructed in every established town and several municipal buildings were also constructed. This is mute evidence of the wealth existing during the past centuries. Bridges

were constructed with large stones brought from Meycauayan, Bulacan, while the floor slabs were imported from China. These bridges were mostly of arch construction requiring little design, and most of the materials necessitated only an expenditure of manual labor, of which fifteen days from each man were given annually for public purposes.



Church at Lubao, Pampanga Province.

Irrigation played another and very important part in the development of agriculture. In the majority of the towns in the province small irrigation systems are to be found, but as none of them provide for any storage to be used during drought, a failure of crops is not uncommon. The system, however, if properly working, will give a harvest of five times the ordinary crop so that it is well worth while to establish such systems.

AGRICULTURAL.

The province is primarily agricultural. The principal crop is sugar and the province ranks second in this staple. The most important sugar producing territory is embraced in 16 out of the 21 municipalities in the province. Rice is second in importance, irrigated rice



Church at Apalit, Pampanga Province.

lands producing 300 cavanes per hectare. Nipa is found in the lowlands and is used for roofing materials, walls of houses, and the juice is converted into alcohol. Fish are raised in large ponds constructed in the lowlands by placing dikes high above the water level.

Truck farming and gardening throughout the province is not

general though the soil is well adapted for it. The schools are making great progress in the introduction of the various kinds of vegetables and gardening is just beginning to prove popular with the younger generation. Cabbage, sweet corn, beets, lettuce, American tomatoes, radishes, green peas, and beans, peppers, egg plants of all varieties, roselle (the jelly plant) and many other vegetables can be produced



Camineros, first-class roads, Pampanga.

the greater part of the year, if properly irrigated. It is stated that cabbage produced in the vicinity of Mt. Arayat will give a yearly income much in excess of any crop produced in the province. Fruits include bananas, in great variety, mangoes, chicos, tamarinds, pineapples and both the native and Hawaiian papayas.

MANUFACTURES.

Agriculture has developed two very important industries in the province. The local sugar mills, of which there are approximately 500 in the province, and the rice mills, which number 45. The production of nipa is responsible for distilleries and the sugar mills, require numerous containers of pottery (locally called pilones) in which the raw sugar is placed and shipped. There are also lumber mills, which work up the woods from Bataan Province and those of Mount Arayat. Besides this there are two rice factories, one cigar and cigarette factory, and a chair factory. A large trade school, located 5 miles



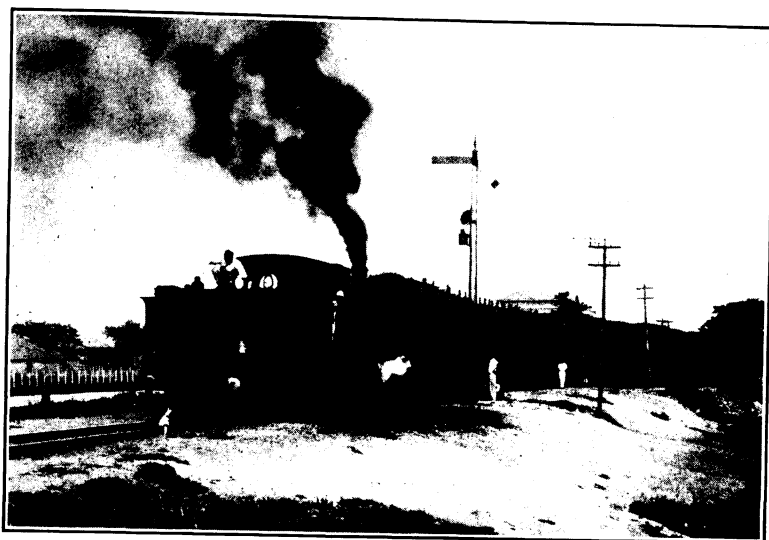
Caminero prize winners, Pampanga.

from the capital, produces furniture and other articles equal to those produced in similar institutions in other provinces.

PUBLIC WORKS.

During the later years of the Spanish administration a railroad was constructed north from Manila. This reached San Fernando,

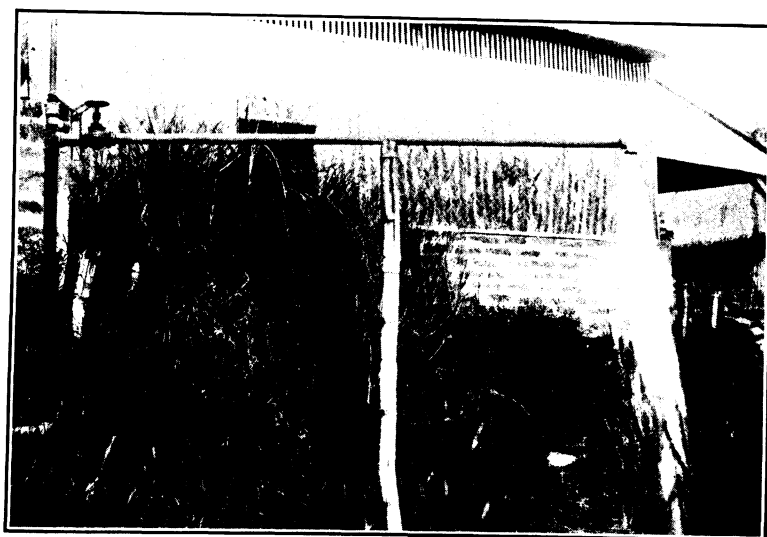
the capital of Pampanga, about the year 1891 and the town of Mabalacat, the most northerly town in the province, about 1892. In 1907 a branch line from San Fernando was extended through Bacolor, Guagua, Lubao and Floridablanca. In the year 1904 a line was extended to the Army post at Camp Stotsenberg, branching from the



Fifteen cars loaded with sugar cane to be sent to Calamba Sugar Estate, Laguna, Pampanga.

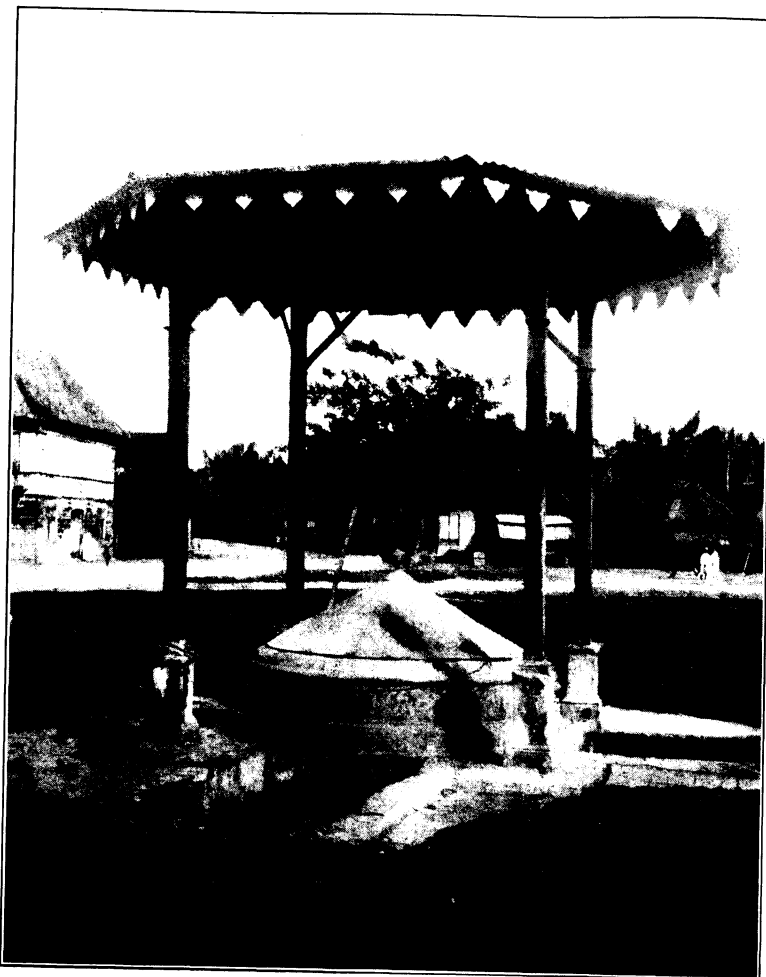
main line at Dao, 4 kilometers from Angeles. Another branch line of 9 kilometers was extended to Magalan in 1910. In 1914 a branch line of 20 kilometers in length was completed to Arayat from San Fernando.

This is the most important asset at the disposition of the people of the province. Twelve towns and one Army post are thus served directly. All of the other towns are but an average distance of 6 kilometers from the railroad. As pointed out before, a great number of these towns are also served by the rivers. The total kilometerage in the province is 107. The total provincial roads required in the province are but 210 kilometers. So it can be seen that Pampanga is more favorably situated in transportation lines than most provinces in the Archipelago. Roads were in the past not considered of prime importance but people, who formerly were contented to go to the railroad station through mud on the backs of carabaos or on horses,



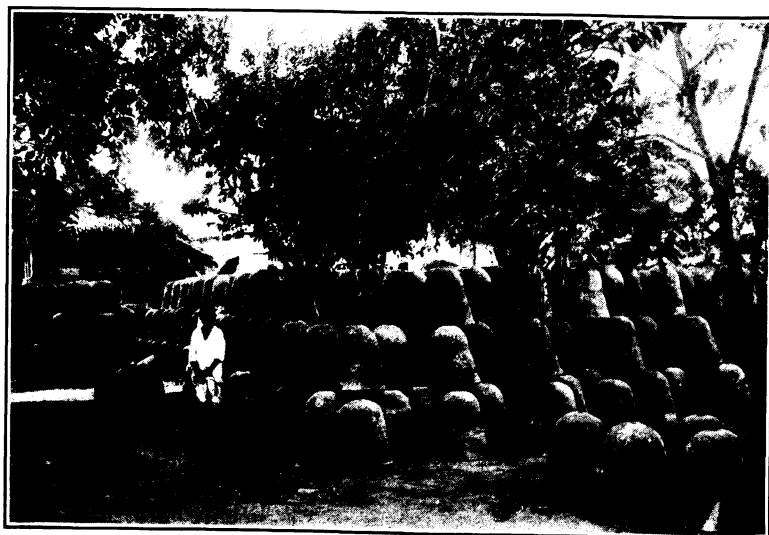
Artesian well at Lubao, Pampanga.

or carry their products in a similar manner, became convinced that from farm to station required a better utility than obtained. With the death of a considerable portion of the draft animals in the province, transportation costs mounted higher and higher and the construction of roads became an important factor in reduction of the



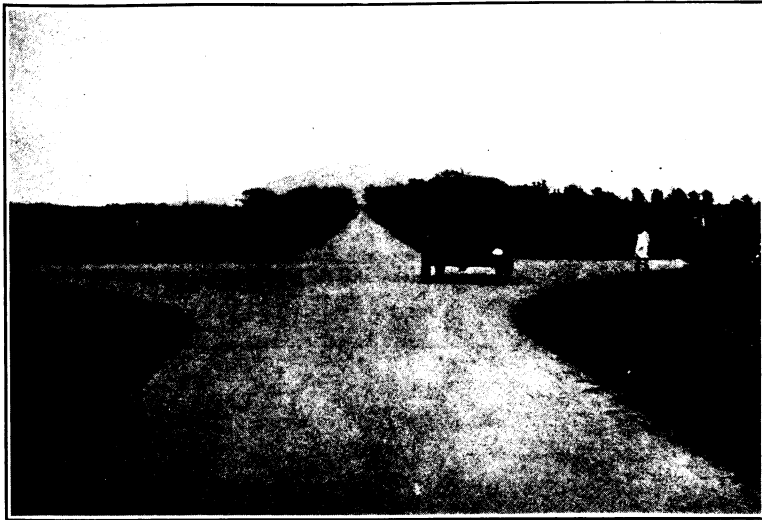
Old Spanish artesian well at Betis, Pampanga Province.

number of animals needed due to the increase of load and lesser time required. At first the roads were damaged by carabao wallows or mud holes, which were repaired by filling them with more mud, leaves or grass and each succeeding year they became worse with the repeated operation. Bridges, however, were constructed over the principal streams and the old system provided for the use of the roads during the dry season only. In all but forty kilometers of road were passable during the rainy season up to two years ago and only twenty-two of these were continuous. The provincial board in 1914 realizing that an expenditure of three-fourths of a million pesos should have brought greater permanent returns, decided that politics



Sugar pilones (clay pottery) used for crude sugar, Pampanga Province.

should take second place to public necessities. They resolved that only first-class roads should be constructed, that each town should be connected, that each road should be finished, when once begun, and connected with the first class roads and that their construction should be in economical order so that the district engineer might be able



Manila-North Road on kilometer 60, Pampanga.

to plan his work more than one month ahead. Since adopting this system it has been possible to improve over 50 kilometers of road connecting with every existing improved road in two years against 40 kilometers constructed in six years, and this at an expenditure considerably less than the previous total. The construction of the railroad line to Arayat was a distinct assistance in road construction as the province previously depended on Bulacan gravel or a poor quality of crushed stone from Floridablanca for metaling. A switch direct to the quarry was installed. Rock is broken by crusher direct into cars, and shipped to nearly all of the projects in the province. It is a great economy, as it is now possible to obtain a rock twice as durable as previously obtained and at less than 60 per cent of the previous cost. This is an important item as rock and its transporta-



Part of 9-kilometer tangent, Manila-Tarlac Road (9,220 meters, or the longest tangent in Pampanga).

tion represents 75 per cent of the cost of roads now being constructed. An analysis of the Arayat rock is given below:

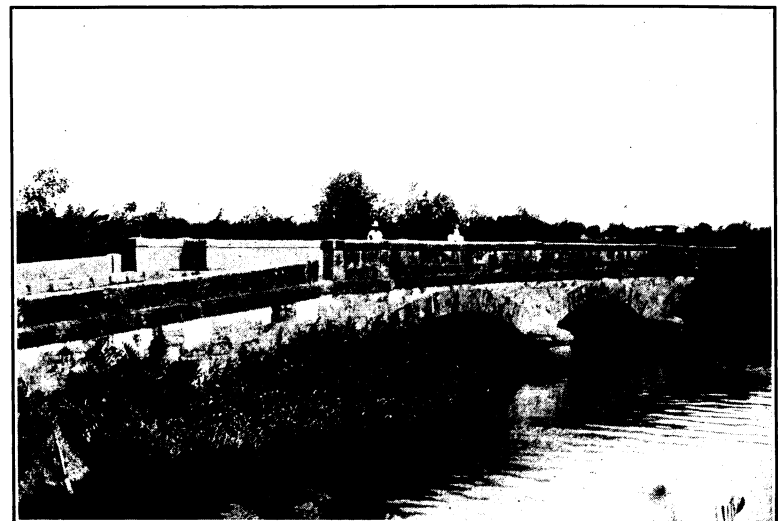
	Per cent.
Abrasion (wear)	2.6
Cementation	75

Classification, basalt and hornblende-andesite. A road with a Telford base will soon be completed running through the province to the north from the Bulacan boundary to the Tarlac boundary.



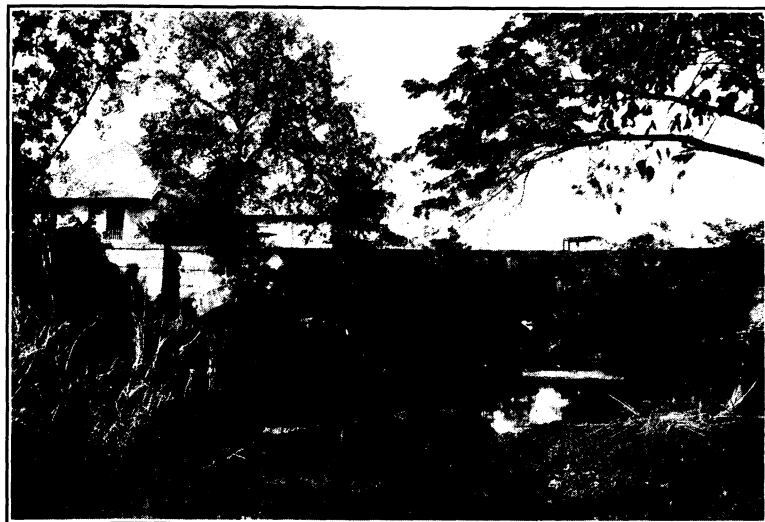
Old San Fernando-Angeles Road (two months after the rainy season), Pampanga Province.

Another road extends east to Arayat a distance but eight kilometers from the Nueva Ecija boundary, which will ultimately be connected with the Nueva Ecija road system. Another road extends to Lubao a distance of but 12 kilometers from the Bataan boundary and it is hoped to connect up with this province in the very near future. An-



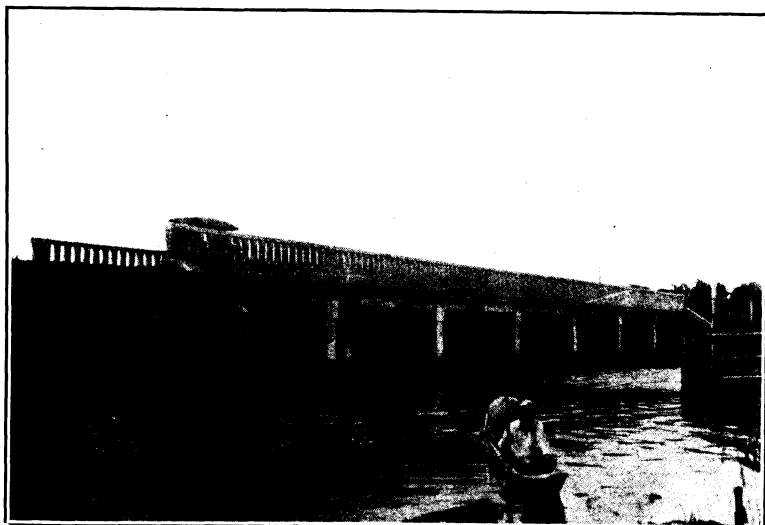
Old Spanish bridge at Guagua, Santa Rita Road, kilometer 84, Pampanga Province.

other road, which was reconstructed this year connects Porac with the railroad station in Angeles. A second road 4 kilometers long was reconstructed this year connecting Santa Rita with the Guagua railroad station, while a third, connecting the towns of Apalit, Macabebe and Masantol with the railroad was also improved during the



Old Spanish bridge on kilometer 78, San Fernando-Arayat Road (built in 1869), Pampanga Province.

past year. In all a total of 23 kilometers of roads perpendicular to the railroad were improved during the past year. The roads parallel to the railroad are a prime necessity to enable people living between stations to reach same and to carry their products over the roads for distances less than 20 kilometers, though the railroad officials consider this detrimental to their business. The construction of a railroad parallel to the road into Arayat resulted in taking one-half of the traffic from the highway. During the Spanish administration there was a total of 412 meters of bridges constructed with a total rise of 181 meters. Since 1898, 642 lineal meters of bridge with a total rise of 265 meters were constructed. Very few bridges are still required in the province, and it is not intended at present to construct bridges where they will only be needed for less than a week a year. With the completion of the road system there will be five complete circuits in the province.

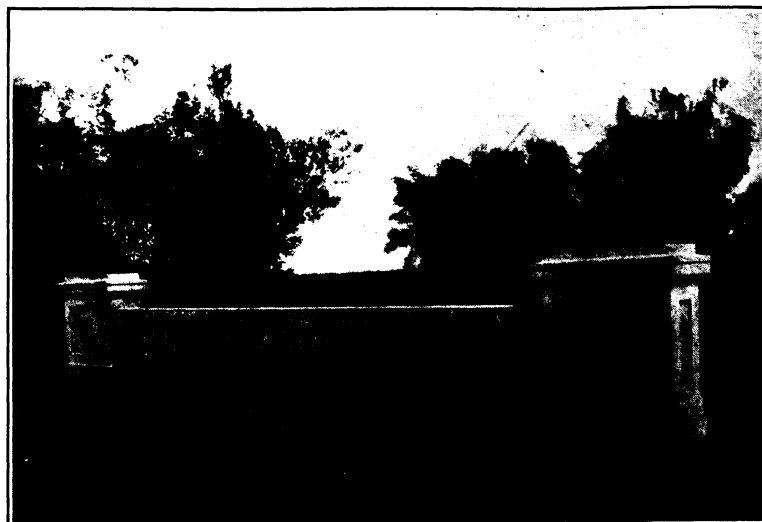


Tiaong Bridge on kilometer 69, Pampanga.

ARNEDO DIKE.

The valley of the Rio Grande de la Pampanga extends to the north, to the northernmost limits of Nueva Ecija and Tarlac, and the source of some of its branches connects with that of the Agno River in the

Province of Pangasinan. It is said that not until the year 1871 did Pampanga suffer from the overflow water of the Pampanga River. In that year water formerly flowing into the Agno River was diverted to the Rio Grande, thus causing a tremendous inundation covering 11 towns in the lower part of the province. This overflow occurred



Ari Bridge, kilometer 62, showing balastres, Pampanga Province.

almost annually thereafter. To prevent this each farmer constructed dikes, to prevent the water from overflowing his own particular lands. It was not until the administration of Governor M. Arnedo that any united effort was made to save the lower part of the province. With an appropriation of ₱25,000, an earth dike approximately 40 kilometers long was constructed along the banks of the river. This has been in service for four years and though it is liable to scour and washout it has served its purpose admirably. It is the intention of the present administration to strengthen and shorten this dike by building spurs and secondary defence works, especially on the curves of the river.

ARTESIAN WELLS.

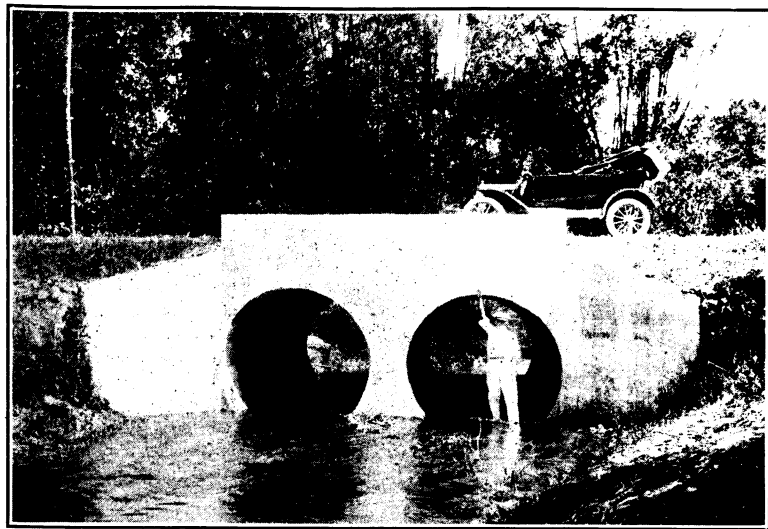
The most important public work for the health of the province is the construction of artesian wells in almost in every barrio and municipality in Pampanga. So successful have these wells been that one



Mexico Bridge on kilometer 79, San Fernando-Arayat Road, Pampanga Province.

can scarcely go in any direction without encountering a flowing well. Only the towns of Angeles, Mabalacat, Magalan and Porac cannot be served in this way. It is hoped, however, to some day supply these towns with potable water from the mountains in their vicinity. The first public artesian well in the Philippine Islands was drilled in

1894 in front of the church in the town of Betis, now a barrio of Guagua. The next was drilled in the town of Sexmoan. The cost of the wells at that time was approximately ₱1,200. The jet rig being then unknown, a solid iron drill was used in reaching the required depth. Previous to these wells (about 1891) the Manila Railroad, drilled a successful well at the station in San Fernando. Most of the municipalities now have access to jet rigs and well



Double 2.25-meter reinforced-concrete pipe culvert; width of roadway 7 meters, cost ₱1,000. Pampanga.

drilling is consequently going on. It has become so popular that municipalities no longer wait for Insular aid and even private individuals put in wells for the public use at their own expense. There are at present about 300 public and about 50 private flowing wells in the province.

PUBLIC BUILDINGS.

Every town in the province has a massive, imposing, though not always elegant, stone church built by the Augustinian friars. Besides these churches there are hundreds of small stone chapels scattered all over the province. For modern structures a reinforced concrete church in San Fernando was constructed by the Methodist Mission and another is now in process of erection in the town of Mexico. This province was one of the first to construct modern



Exterior view of Angeles Market, Pampanga Province.

reinforced concrete provincial and high school buildings. The provincial capital, during the Spanish régime and even up to 1904 was located in Bacolor. A substantial stone provincial building there was destroyed during the revolution against Spain and many ruins

of this period are still visible. The trade school, still located in Bacolor, is an excellent example of these ruins reconstructed. During Spanish administration the school was used for the same purpose.

PUBLIC MARKETS.

Pampanga was also one of the first provinces to adopt the modern system of sanitary public markets. There are now 14 concrete public



San Fernando Central School, Pampanga.

markets in the province of more or less importance. Angeles, Guagua and San Fernando are the important market centers, each receiving market rentals to the extent of about ₱10,000 annually. These markets, as well as the one in Macabebe, also have modern tiendas. Unfortunately seven towns of the province do their marketing across the river in Calumpit in Bulacan Province, but it is hoped that some day it may be possible to establish a market for these people that will be more centrally located for their convenience, besides retaining the market fees in the province.

SCHOOLS.

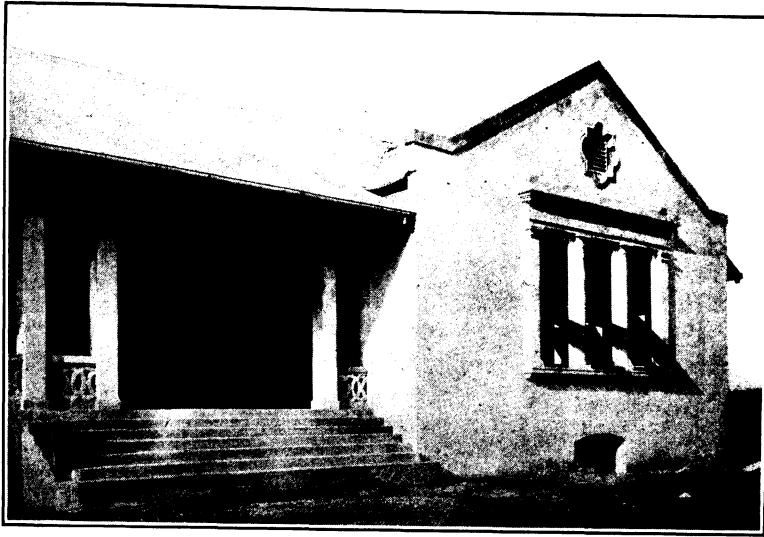
There are many private schools established in the province both for boys and girls and the proximity of the province to Manila enables



Interior view of Angeles Market, Pampanga.

a large proportion of the people to secure a higher education there. Since the establishment of the English language in the Islands there have been constructed 110 standard reinforced-concrete rooms each containing an area of 63 square meters which represents 16 schools.

In addition to these, 5 more permanent school buildings are contemplated, while a great number of schools are being held in nipa or other more permanent buildings. In all there are 120 schools in the province with an enrollment of 17,000 pupils.

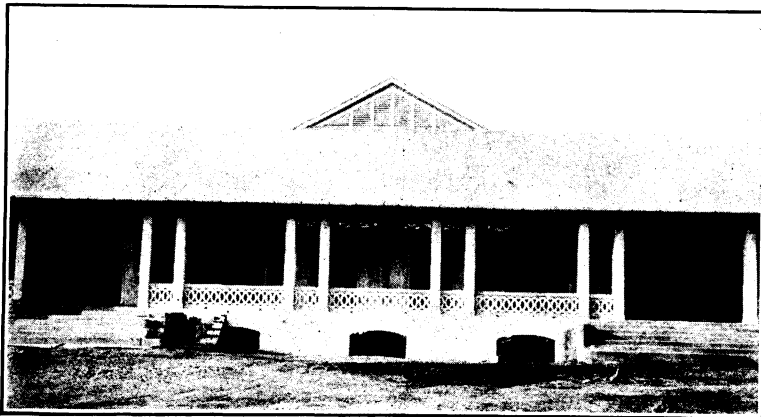


San Fernando Central School, showing Pampanga type partition, Pampanga.

TELEPHONE SYSTEM.

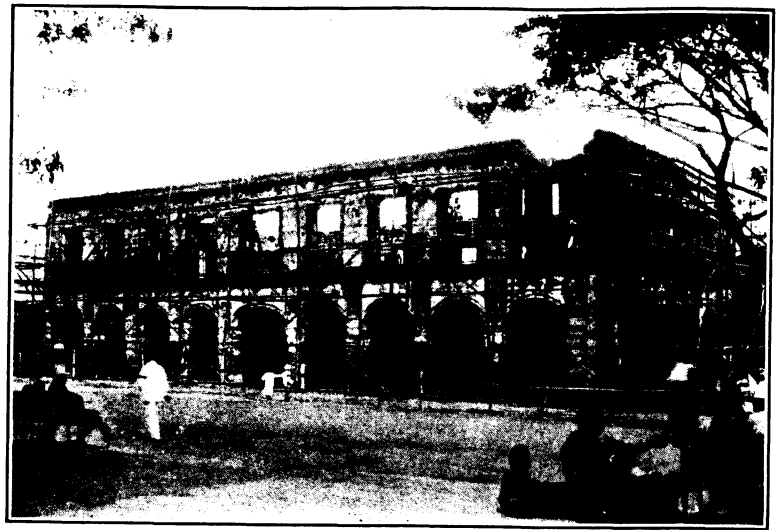
A telephone system, owned by the province, is a very convenient and now almost necessary means of communication. It extends to every town in the province. A telephone station is established in each Municipal building while every office in the provincial building and a number of private dwellings, as well as the most important barrios, and constructing projects in the province, have telephones. The central is located in a permanent tower standing in a prominent place in the provincial grounds. The provincial grounds, by the way, are one of the best kept outside of the city of Manila.

However much the previous cost of roads may have been, they were justifiable even at double their cost. The ordinary cost of both passenger and carabao transportation on first-class roads is 8 to 10 centavos per kilometer for vehicles. On third-class roads the cost varies from 15 centavos in the dry season to 25 centavos and even 30 centavos during the rainy season. The road from San Fernando to Bacolor has 1,300 vehicles passing over it daily. The difference, or say a minimum 10 centavos per vehicle, gives the public a benefit of ₱130 per day, or more than ₱40,000 per kilometer per annum. This represents a maximum. The direct benefit obtained by the public



San Fernando Central School, Pampanga.

on the least traveled first-class roads with 30 vehicles per day is over ₱1,000 per kilometer per annum. The average traffic per kilometer on first-class roads in the province, excluding pedestrians, motor vehicles and pack animals, is 333 per kilometer per day or an



San Fernando municipal building, Pampanga Province, under reconstruction.

average value to the public of ₱33 per kilometer per day, or about ₱12,000 per annum. It can thus be seen that the public each year gains a benefit double the original cost of the road.

ON THE JOB HERE AND THERE.

Mr. W. D. Crossland formerly of this Bureau, is now senior highway engineer, United States Department of Agriculture, Office of Public Roads and Rural Engineering, Washington, D. C. He is stationed at New Baunfels, Texas. Mr. Crossland is in charge of the Texas post road in the capacity of chief engineer. This road is a part of the great scheme proposed by the Great National Highway Association, which scheme embraces a total of 100,000 miles of roads.

Mr. E. C. Blosser, remembered as a district engineer in this Bureau, was promoted to division highway engineer on October 15, 1915, under the Ohio State Highway Commission.

O. R. Kroell, at one time assistant district engineer of Pangasinan, has been heard from at Yellowstone Park, Wyoming, where he is first assistant engineer. He expects to be transferred shortly to a more lucrative position.

PROJECT NOTES BY DISTRICT ENGINEERS.

ALBAY.

During the past quarter Albay Province has been the victim of three typhoons, two of which were the most disastrous in forty years. The first occurred on October 23, the second, which did very little damage, on November 3, and the third on December 6. The force of the wind was greatest during the first typhoon though the floods were greatest during the last.

It is estimated that the roads and bridges of the province were damaged to the extent of about ₱100,000. Immense volumes of sand and boulders were washed down the slopes of the Mayon Volcano, in some cases completely burying the roads and culverts around the base of the mountain and diverting a number of streams into entirely new courses.

The roofs of standard plan schools in Tabaco, San Antonio (Tabaco), and Virac were seriously damaged. Due to a change in the course of a river from Mayon Volcano the Tabaco school is now in the middle of the stream. The fine lawn, hedges, and woven wire fence with concrete posts are completely destroyed, and the sand is almost level with the floor on the front side.

None of the new concrete markets were damaged.

Very little progress has been made on construction during the past quarter. The contractor on the construction of the Quinali Bridge continues faithfully at work but although he began work before the contract was signed he will not be able to complete the job on time on account of the bad weather conditions. During the first typhoon the pile driver was blown off the falsework into the river, though the front end was securely fastened to the falsework. The fact that the falsework on this bridge has stood the typhoons augurs well for the future of this concrete-pile bridge.

AGUSAN.

Delivery of lumber for the construction of the provincial jail was somewhat delayed due to scarcity of transportation from Cebu, but with the delivery of the lumber and the arrival of an American Foreman the prosecution of the work was resumed in earnest about a month since. All the concrete work has been finished, and it is hoped that by the end of January, 1916, the structure will be completed.

During the southwest monsoon transportation from Surigao to Agusan was difficult and nothing was done on the Butuan-Cabadbaran Road, except constructing temporary bridges, but at the beginning of this quarter the work was vigorously commenced and the crossings have all been bridged except the Agusan River. Carts have no difficulty any longer in going over the road, except on the ungraded section, and the grading on this, though it is now the rainy season in this part of the Islands, is being pushed more than ever.

At the beginning of the year there were four 2-room frame school buildings pending, but due to their locations being so far in the interior of the province, nothing has been done except on the Prosperidad school building, which is now finished. From Butuan it takes more than a week by launch and baroto on the Agusan River to Waloe, and from one location of a school to another it also takes a week.

Construction and maintenance of trails in the interior of the province have been carried on under the immediate charge of the Assistant to the Governor. River control has been carried out in the same manner.

The driving of artesian wells is getting to be somewhat popular in the province. Many private persons have gone to the provincial board with requests to rent the jet rigs, they themselves to pay for materials, labor and transportation. The rent as calculated by this office is ten per cent of all expenditures incurred. The province since the beginning of the year has added eight more wells to its list. Five have been driven since July, two in Butuan, one in Agusan, and two in Cabadbaran. The two in Butuan are each 250 feet deep and have a flow of 50 gallons a minute each. The water is not so brackish as that from the old wells and is serviceable for drinking. One of the wells in Cabadbaran is only 200 feet deep and flows 61 gallons a minute of excellent drinking water.

AMBOS CAMARINES.

During the typhoon of October 23 a number of buildings, including the provincial building and various markets and schools, were unroofed by the wind. Without doubt, in future plans for buildings in this section, the details of fastening down the roofs should be made stronger. The new schoolhouse at Iriga, however, was not damaged, and offered a haven of refuge to the homeless.

The rainfall for December 1 to 22 was about three times the normal, and 419.2 mm. of water fell during the period from December 18 to 21, an exceptional rainfall for this region. The high waters, however, have been kind to the roads, so that although many kilometers were inundated only a small amount of damage was done, the total, including bridges, being only about ₱25,000.

It has been found necessary to redesign all bridges on the Pili-Tigaon Road since the typhoon. The road subgrade suffered but little from the floods. The Caditaa Bridge, a 12-meter reinforced-concrete girder bridge has just been completed. Several small culverts have also been completed. Labor on the road has been scarce but is now picking up. About five hundred men are now working, and in January this should increase to eight hundred. The subgrade is under construction at Mabatobato and Morienes at this time.

Work on the Pamplona school building was temporarily suspended so as to repair damages to the government building in Naga, but has since been resumed. The work of repairing the government and high school buildings is about complete. It will be necessary to wait for dryer weather to do the painting.

The wrecking of the trade-school building is being done at the same time as the other repair work but as the Bureau of Education desires to remodel same, the reconstruction has not yet been begun.

ANTIQUE.

The preliminary survey of the Antique-Iloilo Interprovincial Road has been completed. The line on the Antique side to the provincial boundary from the present first class road is 7.8 kilometers. Preliminary plan, profile and estimate have been submitted for approval. The total expenses to November 30 on this preliminary work including supervision and surcharges were ₱324.26.

The annual exodus of contract laborers to Negros began in the latter part of September, the rice crop in Sibalom and nearby places claimed a great number of men, and between the two the work on the North Road has been delayed considerably. Only 2.1 kilo-

meters of road were rolled, making the section first-class to Km. 29.1 on this road. The subgrade work is still on Km. 31.

The work at Bacat Daraga Point at Km. 53 on the North Road was completed October 23. This makes the road continuous to Km. 80.6 near Culasi. Before the cut was made at this point cart traffic had to leave the road at Km. 52.2, pass along the beach, when the tide was sufficiently low, and get on the road again at Km. 54.1.

Two spans of the Buñgol Bridge are completed and the forms for the third span are in place. Only the north abutment piles remain to be driven. Laborers are sadly lacking, so that 6 carpenters, 4 masons, 9 pile-driver men and a blacksmith had to be brought from San José and to be used as common laborers. The total expenditures to November 30 were ₱13,921.72 including labor, inspection and materials. It is expected to finish construction about the middle of January, 1916.



Kilometer 1, San José-Beach Road, Antique Province.

The Culasi school, a Standard Plan No. 7, was completed on Nov. 6th after 124 days of actual construction at a total cost of ₱15,674.42. All sand and gravel was furnished by the people of Culasi free at the school site. The school was accepted by the Division Superintendent of Schools of Antique on December 9, was occupied on the following day and a preliminary inaugural program with the usual address was presented on the evening of December 11. The formal opening of the school building, however, was held on December 29, in connection with the Municipal Fair and Carnival.

A survey of the San Pedro-Sibalom Road, 8.6 kilometers has been made and plan submitted. Cost of the survey, ₱135.80.

Plans for the Ipil River Bridge on Km. 59.8. Barbaza-Tibiao Section of the San Jose-North Road, have been received and materials have been requisitioned. This will be a 3-span 7.0 meter reinforced-concrete deck girder on reinforced-concrete piles. As soon as the last abutment pile of the Buñgol Bridge in Culasi is driven the pile-driver outfit will be shipped to Ipil.

Other bridges to be constructed as soon as funds are made available are: Calawagan River Bridge on Km. 67.3 Barbaza-Tibiao section of the San Jose-North Road a 3-span 9.0-meter reinforced-concrete deck girder on reinforced-concrete piles, and Catungan River Bridge on Km. 7.7 Malandog-Sibalom Road a 4-span 9-meter reinforced-concrete deck girder on reinforced-concrete piles. Both of these are on 45° skew.

BATAAN.

Five hundred lineal meters of the Balanga-Orion Road have been completed on a 15-meter right of way.

The laborers are distributed along the different portions of the Orion-Limay Road where heavy cuts and fills are encountered, accomplishing the heaviest construction first. It is proposed to open this road to traffic early next year.

Repairs to the collapsible bridge on the Talisay River have been in progress with a view to its opening to wheel traffic before Christmas. Three pile units were cut off by the big flood in November. The inadvisability of using lauan for piling with this type of bridge is plainly shown. All the piles cut off by the flood were of lauan. The liusin piles are still in good condition, and this wood is being employed for the new piles.

Funds are available for the construction of a fireproof concrete vault in the provincial government building. The plan has been prepared in this office and submitted to the Consulting Architect for correction and approval, and as soon as returned construction will be started.

The Pilar irrigation system has again brought about a bountiful harvest, and it is expected that by next year more areas of land will be brought within the system, thereby increasing the hectareage of land irrigable. The installation of a waterwheel along one of the main ditches made it possible to lift the water about eight-tenths of a meter and to irrigate over four hectares of land adjoining. It is believed that from ten to sixteen hectares may be supplied from this system when the ditches are arranged with better grades.

BENGUET.

Two typhoons during the month of November and frequent rains in December have seriously retarded the work of resurfacing the Naguilian Road, and have caused considerable damage to the Benguet Road and to the roads in the City of Baguio.

The Benguet Automobile Line carried 775 passengers and a total of 38,900 kilos of express and baggage during the period from October 1 to December 20, 1915.

Surveys and investigations of the Cervantes trail, from Tagudin to Cervantes, have been completed and a report and estimate is being prepared as to the feasibility of converting this trail into an automobile highway.

Fifteen thousand pesos has been appropriated for the maintenance and repair of bridges on the Benguet Road. The suspension bridge at Camp Five, span 103.7 m., is being reconstructed. It is also proposed to rebuild two other small bridges out of this appropriation.

Kilometer posts cut to standard size from stone available on the Naguilian Road have been placed as far as Kilometer 34. The work was performed by Ifugao masons at a cost of approximately ₱2 each.

BOHOL.

The subgrade work of the Loay Interior Road was completed early in October up to the town of Bilar. The rock crusher ordered from the States has just been received, but on account of recent rains the subgrade of the Loay-Loboc section is too soft to permit the transportation of the crusher to Kilometer 31 where it is proposed to crush rock. Surfacing operations will be started as soon as the crusher reaches this place. The Bilar-Batuan-Carmen sections, Kilometer 42 to Kilometer 59, have been surveyed. The road is practically level except in two places near the towns of Butuan and Carmen.

Anahauan Bridge has been completed. The people of Garcia Hernandez have furnished almost gratis piles and lumber for the Garcia River bridges. The municipal president, Mr. Nicolas Jamero, deserves praise for his work in arousing public interest among the people.

Messrs. Kipp & York completed the Ubay school building (plan No. 7) in November. Mabini school (plan No. 7) was also completed during the same month, by administration.

An appropriation of ₱18,400 for the construction of Loay waterworks has been made available. This amount will not be sufficient

to build the entire system but will build the intake and pipe line to Loay. The municipal council will furnish 5,000 days' of voluntary labor.

BULACAN.

The plans for an addition to the Sibul Springs bathhouse have been completed and the work of construction will be undertaken in the near future by administration. This addition to the bathhouse will contain 16 showerbaths which have been installed in the hope that they will prove ample to meet the heavy demand of the Sibul Springs bathing season which usually comes during the months of March, April and May. With these added facilities the public will be much better served than has been possible with the limited capacity of the present bathhouse.

The Guiguinto school, a four-room structure, is nearing completion and should be occupied some time about the middle of January.

If the present rate of progress continues, the Bigaa schoolhouse, a standard six-room Gabaldon building, will be completed about the first of February.

The municipality of Hagonoy has recently acquired a considerable addition to its market site and is planning to remodel its twelve tiendas and to construct a modern slaughterhouse. The work of clearing the newly acquired land and of placing it in proper condition for market purposes is progressing rapidly.

BATANGAS.

On account of the rainy season road construction has been at a standstill during the past three months. Road maintenance has been the only kind of road work, but this has been quite heavy on account of the three baguios which occurred during the quarter. No serious damage was done to any of the roads or bridges by the baguios, the worst being the washing out of the binder on nearly all the road and in a few sections where water was over the road and the entire surfacing taken away. The heaviest damage suffered by the province during the typhoons was the loss of the dykes in the Calumpang River. The water scoured out the rock in behind the concrete and thus obtained a better hold on the concrete slabs, completely destroying one dyke and seriously damaging the other. The entire loss amounted to approximately ₱5,000.

Building work has been slow on account of the scarcity of labor at times, and of the rains which prevented the transportation of materials.

A modern toilet has been built for the Batangas High School, water being supplied from the provincial water system. A septic vault was built to take care of the sewage. This service has been in use now for one month and has given considerable trouble largely due to the failure of the students to make proper use of it. It is believed that an automatic flush system would have proved more satisfactory.

On account of the impossibility of transporting materials over the roads near Bolbok, the work on the plan No. 10 school at that place has been slow. Almost two months have been lost in waiting for materials.

Bids were asked for the construction of a standard plan No. 4 school at Talisay and a standard plan No. 10 school at Lemery, both to be opened on the 18th of December. No bids were received on the former and only a partial bid on the latter, so both of these schools will be begun by administration just after the first of January.

Construction has commenced by administration on the 18 m. x 30 m. market in the municipality of San José.

Materials have just been received and work by administration will start within a few days on the construction of a matadero and midden-shed at the Batangas Municipal Market. Approximately ₱15,000 is available for these two buildings.

Work has progressed rather slowly on the construction of the Mataywanac and Kaytitinga bridges. Labor has been scarce and on the Kaytitinga it has been almost impossible to get materials to the site. The Mataywanac, a 15-meter semicircular arch, was poured on November 23. The Baguio of December 7 took out part of the false work, but fortunately the concrete was of sufficient age so that it was not damaged in the least. These bridges were not damaged by the high water of either baguio.

The principal project of this province for the past several months has been the Taal Waterworks, which although not complete was inaugurated according to schedule on December 12. The pipe and specials furnished by Frank L. Strong Machinery Co. under contract were received on August 25, and work was started immediately. During construction a very agreeable addition to the water supply was discovered. The original plan called for the water to come from three springs, to be piped into a centrally dug well from these

springs. The dry season flow of the three springs combined is approximately 300,000 gallons per 24 hours. The well was started near one of the springs and before the depth intended was reached an artesian well appeared with a flow of 250,000 gallons per day one meter below the surface of the ground. The flow at the bottom of the suction pipe is not known, as there are no pumps sufficient to lower the water that far. The pumping plant is more or less provincial. The permanent pumps have been installed with a temporary engine. The permanent engines are to be two 20 H. P. Diesel Otto engines, to be furnished by Germann & Co., but on account of the war they have not been received and the date of their arrival is very indefinite.

CAGAYAN.

Little has been accomplished this quarter due to the exceptionally heavy rainfall in this province and the upper basin of the Cagayan River and its tributaries. The total rainfall in Tuguegarao for October was 510 mm. and for November was 544 mm. The river has been at flood stage almost continuously since the 10th of October. On November 4 and again on the 30th, the river at Tuguegarao rose about 40 feet above low water.

A baguio passed over the province on October 29 which together with the accompanying flood caused probably ₱3,000 damage to the provincial roads. The first class road between Tuguegarao and Alcala was overflowed in many places but not damaged except by washing away the surface binder. The wind attained a velocity of about 70 miles per hour.

Considering the difficulties under which work has been carried on, the construction of Babogan Bridge is progressing satisfactorily. One pier has been completed, twenty-five reinforced piles have been driven, the other twenty-five necessary to complete the structure have been cast, and the work of casting the caps for the reinforced concrete pile bents is now in progress.

As a matter of economy first class road construction has been practically suspended between Tuguegarao and Alcala, until the beginning of the dry season in January.

The dredge *J. M. Dickinson*, which has been tied up at Aparri since October 12, is being put into condition to resume work at Camalaniugan and Lal-lo as soon as the river reaches its normal stage.

CAVITE.

The annual typhoon with its heavy rains did more than ordinary damage to Cavite roads on December 7 and 8. The wind at Cavite was blowing about 75 miles per hour across Cañacao Bay from two until three o'clock on the afternoon of December 8th. The water was blown against the causeway that connects Cavite with its barrio of San Roque with such force that it was carried in large volumes clear across the causeway, and dashed in solid sheets against the adobe retaining wall on the opposite side. The force was sufficient to completely undermine and destroy approximately 50 lineal meters of this old Spanish wall, which has been standing since 1880. The causeway is 300 meters long and 50 meters wide, being protected on the Bacoar side with an adobe stone retaining wall and on the Cañacao side with China granite in boulders of about 10 inches in diameter laid up in mortar on a slope of approximately 4 to 1. This side has already been washed out considerably, but the adobe retaining wall was in good condition until the last storm. It is proposed to build a riprap wall using one-ton stones, laying them directly against the present wall. This will cost about ₱15,000, but is the best method for protecting the causeway economically.

The road from Noveleta to Malabon, a distance of 5 kilometers, had practically every bit of the gravel surfacing washed off, and in at least three places the adobe subgrade was washed out. The road is located directly on top of a high bank on the Rio Grande for 3 kilometers of the distance, and the bank is continually caving in. The remedy is to relocate the route and put it back in the rice paddies away from the river. This will give a better and shorter route and eliminate the annual damage caused by high water. The present alignment is in accordance with the scheme used in Spanish times to locate roads on river banks so that gravel and sand could be secured at the minimum cost.

The Naic-Maragondon Road will be completed during the coming year as a first-class highway with broken stone surfacing. It is 5.7 kilometers long and extends parallel with but back about two kilometers from Manila Bay and is opposite Corregidor. The route goes thru fine irrigated sugar and rice lands and connects the town of Maragondon with the railway outlet at Naic, traversing a municipality of 22,500 people. Half the culverts were completed last year and one kilometer of subgrade was built over a very bad place. The amount necessary to complete the road will be approximately ₱65,000.00.

The combination adobe stone arch and wooden trestle bridge at Zapote was damaged seriously this year by scouring around the arch pier and abutment. It is an old Spanish structure which originally had two 8.5-meter arch spans, but during the insurrections in 1899 one arch was shot out to prevent the passing of troops and afterwards was replaced by a wooden frame structure. This has served the province well for fifteen years, but will have to be replaced now with a new structure. The river has a water span of 100 feet and is 6 feet deep at low tide. It is proposed to erect a steel span of 120 feet length just below the present bridge so that the old bridge can be used during the construction of the new road. This will give a better location as it will eliminate one curve, the present bridge having a curve at each end.

CEBU.

The dredging of Cebu Harbor as planned for the year was finished in October. Careful soundings show a minimum depth of 29.5 feet along the reinforced-concrete wharf, 25.5 feet from the Custom House to the offset of the sea wall, and 18.0 feet from there to a point near the market. The value of this work is shown by the fact that several of the largest vessels visiting these waters have called recently at Cebu and have been accommodated without difficulty.

Preliminary investigations are now being made for the proposed wharf extension along the east waterfront. A topographical survey of the shore and tide lands has been made and a sounding out fit is at work on test boring for foundation and dredging data over a large area. The design contemplated provides for a reinforced concrete deck supported by cylinder pier. In addition to providing a more sheltered berth for the smaller type of shipping this project will make possible the reclamation of a large area of tide land.

The waterfront fill which was being made with dredged material is being finished with coral rock and earth furnished by a local contractor at a cost of about ₱0.75 per cubic meter in place.

Paving of the waterfront street is being pushed rapidly to completion. Parts not subject to wave action are being laid with an asphalt binder but without the wearing coat, and show up well under the heavy traffic. In connection with this work, the railroad track has been repaired and rebalasted, and other minor improvements have been made to the arrastre plant.

An appropriation for repairs to the customhouse became available in October and is being expended as follows: new concrete valve boxes with cast iron covers have been installed on the waterfront water system; the interior of the customhouse has been painted with cold water paint, and presents an excellent appearance; a portion of the concrete floor is being surfaced, the wearing surface, which was badly cracked and worn, having been found to consist of a very poor mortar, apparently laid after the base had set, and peeling off readily in large pieces; and the underlying surface is being treated with acid and cement grout, after which a 1:2 surfacing is applied and finished with a hardening preparation.

A much needed market will soon be opened in Cebu on a site on the east waterfront recently purchased by the province. An old bodega built of coral rock with corrugated-iron roof which was included in the purchase is being adapted for the purpose at a cost of about ₱5,000. The front wall has been replaced by a reinforced-concrete wall with iron gates, and a concrete floor and standard tables are being installed. The work is being done by administration and with local funds.

The Cebu-North Road construction has been delayed by the heavy rains of the past three months. The work is completed except for 16 kilometers of surfacing. During the wet weather it proved impossible to make any economical progress, as the subgrade was too soft to permit of surfacing operations.

Two standard schools have just been completed by contract, one being a four-room standard plan at Daanbantayan and the other a standard No. 7 at Bantayan. These jobs presented the usual difficulties as to transportation and the contractors did very good work in finishing them promptly.

Two additional rooms have been added to the San Fernando school, making the building a standard plan No. 6. The first four rooms were constructed in 1910.

A small waterworks system has been constructed in Naga, utilizing a spring some 2 kilometers from town. The flow is small but it will furnish drinking water for the people. Water conditions in this town have been very bad in the past and the new system is expected to improve the general health to a marked extent. The work was done from municipal funds entirely.

The construction of the Sibonga water system is held up awaiting the arrival of the 6-inch pipe for the line from the distribution tank

to the town. This pipe is to be furnished by the Government and placed by the contractors. Inasmuch as it has been ordered for some time its early arrival is expected, when it will only be a matter of days for the completion of the work.

Two good pumping wells have been completed recently by the Artesian Well Division, one in Asturias and one in Tuburan. These wells are now supplying all the inhabitants of their respective poblaciones with water. The drilling of artesian wells has not been very successful in Cebu Province except from the town of Toledo, on the West Coast, north, including Balamban and Asturias, to Tuburan. Eight out of eleven attempts in this region have proved successful.

Two reinforced-concrete culverts have been completed in the town of Alcantara on the first-class road. One was a standard 3 by 3 meters and the other 1.50 by 2 meters.

The Sibonga bridge is now under construction by contract. This bridge will be a very handsome structure when completed and will doubtless attract considerable attention on account of its artistic design. It is an 11-meter arch and has a width of 7.46 meters.

A sanitary system now being installed, for the Cebu Central School and High School will consist for the present of two toilets, one with fourteen and one with ten bowls and a septic tank with filter beds of sufficient capacity to take care of a third toilet to be built later. The buildings are of reinforced concrete with galvanized iron roofs. The bowls are to be set with their rims flush with the concrete floor and will be flushed directly from the service pipes. The work is being done by administration.

COTABATO.

Work has been progressing slowly on the Cotabato-Tamontaka Road during the months of October and November, owing to heavy rains. No stone was placed during this time, but a large deposit of gravel from the Limapatoy River was made in Cotabato in preparation for commencement of hauling when dry weather sets in. A heavy sidehill cut in hard limestone is being made on the section around Constabulary Hill, and the rock obtained is being broken to 4-inch size for use in the bottom course of the metaling. The hauling is done by bull-carts and has been slow, as there are only a few available. However, as the road nears completion various persons have signified their intention of buying more vehicles, one planter having already ordered six carts. The government has placed an order for carts, and they can be sold as soon as received. The road is 6.25 kilometers in length and is located through a very populous agricultural section. Five and one-half kilometers of this road can be declared first-class by the end of the year, the first declaration of first-class road in Cotabato Province. The cost of the road complete will be ₱25,000 exclusive of some grading and culverts built under the former government of the Moro Province.

Work has been delayed on the Kudarangan-Fort Pikit road on account of heavy rains, but with the dry season at hand has been commenced again and will be pushed as far as the funds available allow. Two kilometers have been graded to seven-meter width to date. This is the most important piece of road construction in the province as it lies in a very rich rice producing area recently colonized by Moros and Filipinos. The present earth trail is practically impassable for long periods at a time so that it is very difficult to get food stuffs and produce in and out to the river which is the main artery of transportation for the region. The section is 24 kilometers long, cutting across a wide bend in the river. About 30 kilometers of the distance by water from Kudarangan to Fort Pikit will be saved.

Telephone construction has been pushed during the past year. The Fort Pikit-Cabacan line has been in operation for about two months. Cabacan is 120 kilometers above Cotabato on the Cotabato River at the mouth of the Cabacan River. It is the junction of the trails to Bukidnon and Davao, on which telephone lines will be placed later. The construction of the first section of the Glan line between Reina Regente and Buluan is well advanced and material is on hand to complete the entire line to Glan. This work will be rather difficult, especially south of Lake Buluan, as a large part of it is two or three days' hike from the nearest point of communication which is itself from one to two days by vinta from the Cotabato River. The cost of transportation of material is about eight centavos per kilo or ₱12 per mile of line for wire and brackets. The distance between Fort Reina Regente and Glan is about 120 miles and the line will cost ₱11,000 when completed of which ₱8,000 has been made available for expenditure this year.

The deep-well rig operating at Dulawan has penetrated through 840 feet of soft blue clay which hardens to shale on exposure to air. There is a small amount of salt water at a depth of 300 feet and again at a depth of 750 feet but so far no potable water has been encountered. There is no data available as to the depth of the blue

clay, but it is expected that good water will be obtained if porous material can be reached by the machine within its limit of 2,000 feet. The military authorities are drilling another well on the reservation at Parang and have penetrated through rock to a considerable depth, but have found nothing to date.

The government rice mill in Cotabato will be in operation before the first of the year. The work is being rushed in order to take care of the crop which is now being harvested. The estimated cost was ₱50,000 with machinery installed and it will be finished for something under this amount, although the soft mud of the site has necessitated exceptionally heavy concrete foundations for the building and machinery. About 200 cubic meters have been placed in the footings and floor. Six hundred cubic meters of earth fill were placed under the building, and a bin holding 5,000 cavanos of palay is being built in which to store the palay after it has been run through the drier. By use of this bin there will be no loss of palay from being stored in a bodega while wet and the usual expensive method of spreading it in the sun to dry before storing it preparatory to milling need not be resorted to. The bin is so arranged that the palay flows by gravity to the elevators which deliver it to the milling machinery.

Preliminary surveys have been made for an irrigation canal from the Maridagao River to the colonies near Fort Pikit. It develops that a diversion weir about 50 meters long will be required, with falling gates to lift the water about 1.5 meters. There would be a heavy cutting near the river for a distance of 2 kilometers, but three very convenient swamps have been found extending from the Maridagao River toward Pikit for 3 kilometers, into which the water could be turned. These swamps are long and narrow and no work would have to be done on them. They would reduce the cost of the work very materially and would balance the cost of the heavy cut and diversion weir. Another line from Colony No. 1 to the Malitubug River will have to be surveyed before definite information can be given. This is a longer line, being about sixteen kilometers against thirteen for the Maridagao location. A short tunnel would probably have to be built, but after the ridge dividing the colonies from the Malitubug has been penetrated the water could be conducted to the agricultural land by a small stream which flows into the Silik Creek near colony No. 1 and only a few kilometers of canal would have to be built.

Plans have been submitted for a waterworks and a river wall at Cotabato. The suggested plan for the waterworks is to bring water from Simuay River to Cotabato, a distance of 3 kilometers, through a 14-inch concrete conduit with a cast-iron section laid under the river. This conduit will deliver water to two No. 80 Rife rams under a head of 6 feet. These rams will deliver to a reservoir on a hill 190 feet above the town, from which the water will flow to the distribution system through a 6-inch main, delivering 600 gallons per minute for fire-protection purposes.

Plans have been requested for a reinforced-concrete pile bridge across the Tarbung Estero on the Cotabato-Tamontaka Road.

The Parang Waterworks has been held up pending a change in the plans and location. This change has been necessitated because of the difficulty of obtaining the easement desired from the owners of the property on which the original location was made. This difficulty has been overcome and work will be stated as soon as the revised plans are received.

The plans for the new hospital at Cotabato have been finished and it is expected that work can be commenced on this project by the first of the year. An appropriation of twenty thousand pesos is available. The building will fill a long felt want and will aid the health department in the prosecution of its work, besides adding much to the general good appearance of this place.

An experiment in raising water from the river for irrigation by means of current wheels is being tried. The first wheel will be mounted at Kudarangan Agricultural School as soon as the river falls enough so that data can be obtained on the flow at low stages.

DAVAO.

The province has recently received a new 10-ton road roller and hopes to start first-class road construction on the Davao-South Road soon after the first of the year.

Construction of the Cuabo-Mati-Boston telephone line is under way and 30 kilometers of line will soon be in operation. Work will soon be started on the wireless station at Cuabo, which is to connect the telephone line with Davao.

Preliminary surveys are being made for the proposed waterworks system for the municipalities of Davao, Santa Cruz and Mati.

ILOCOS NORTE.

The Lawag Bridge extension over the washed-out section of the spillway, Lawag-San Nicolas Road, has been completed at a cost of approximately ₱14,000.

The Badoc and Bacarra Markets have been completed by administration and are now ready for occupancy. The following tabulation exhibits the financial condition of the two projects:

	Badoc—15 by 35 meters.		Bacarra—18 by 38 meters.	
Appropriations:				
Insular loan	₱12,000.00		₱12,000.00	
Municipal allotment	1,000.00			
Insular aid	2.00			
		₱13,002.00		₱12,000.00
Certified expenditures:				
Miscellaneous	239.45		331.84	
Labor	1,067.32		1,835.93	
Materials	6,372.44		5,734.52	
Surcharges	517.68		530.37	
		8,196.89		8,432.66
Outstanding obligations:				
Miscellaneous			3.00	
Labor				
Materials	996.00		150.00	
Surcharges	366.00		324.00	
		1,362.00		477.00
Available balance		3,443.11		3,090.34

NOTE.—The material obligation of Badoc Market includes the amount of ₱406.00, estimated cost of supplies requisitioned for the tables.

Some of the tables for the Badoc Market have already been put in; the others must wait for materials. Recommendation has been made to appropriate the Bacarra Market balance for the installation of standard sales tables.

The outhouses for Lawag East Central School will be completed soon.

Badoc School, plan No. 7, has been laid out since the rice has been harvested from the site. All forms have already been made out and the steel cut to dimensions. Concrete work will soon be started.

The reconstruction of San Nicolas School is only waiting for materials from Manila, and as soon as they arrive work will commence. The municipal council has requested that all foremen, capacitates, carpenters and laborers on this job be from San Nicolas as they offer to work one day per week without pay. This is possible, for the majority of Bureau of Public Works men in this province are from San Nicolas.

A schoolhouse similar to plan No. 7 will soon be under way at Piddig. Brick, lime, sand, gravel, timber, and labor are to be given free by the municipality. Materials such as roofing iron and hardware will be purchased from the Bureau of Supply. Authority is being requested from Manila to work on such a building.

The Paoay School is waiting for an Insular allotment. There is over ₱5,000 on hand as the municipal fund.

The work on the San Nicolas-Dingras Road is progressing very rapidly. Eight kilometers of this road have been awarded to Contractor Daniel Galza at ₱3,000 per kilometer. During the period from October 28 to December 11, or say five weeks, the subgrade for 4 kilometers has been completed. There are 500 laborers working every day. Efforts will be made to secure an appropriation sufficiently large to complete the road to Milamilan, where it joins the Dingras Road. During the rainy season next year we expect to see carts on this road loaded with rice from Dingras to Lawag.

The opening of a trail from Bangui to Claveria will probably take place if all the interested parties agree to give their shares. Funds should be either special allotment from the Legislature or else the expenditures should be borne by the Provinces of Cagayan, Ilocos Norte and Mountain Province. A considerable study will be required for the best location of the proposed trail especially on the dangerous Mountain Patapat section. This location will be the basis for a wider road in the years to come.

It is expected that a standard building for the provincial capital will be erected during the year 1916. The present Provincial Building has been greatly damaged by the recent typhoon and earthquake, and its repair or reconstruction is not warranted.

ILOCOS SUR.

During the last six months 9.1 kilometers of first-class road have been constructed, at a cost from ₱4,800 to ₱5,800 per kilometer, on the Vigan-North and Vigan-South Roads. Seventy-two pipe culverts have been placed most of them on the Vigan-South Road, especially on the Santa Cruz diversion.

The Cabugao market, Project No. 51, has been completed. It is a Standard Type A, size 21 by 43.5 meters. The following is the history and actual cost of construction, including the purchase price of land for site:

Project No. 51, Construction Cabugao market. Construction authorized August 4, 1914. Plans prepared by the Bureau of Public Works. Constructed by administration.	
Estimated cost	₱19,006.00
Amount of donated labor	none
Amount of donated materials	none
Amount of donated transportation	none
Miscellaneous	466.77
Labor	2,678.39
Materials	9,208.12
Surcharges	928.34
Total	13,281.62
Liabilities:	
Land value	1,664.88
Miscellaneous	28.30
Labor	95.00
Materials	458.90
Surcharges	324.00
Total	15,852.70
Appropriations:	
Municipal funds	₱1,500.00
Insular funds	15,000.00
	16,500.00
Balance to be used for constructing concrete posts and woven wire fencing	647.30

The Santo Domingo market, Project No. 50, has been completed. It is of standard type size 18 by 42 meters. The following is the actual cost of construction, including the price for the land which the market occupies:

Project No. 50, Construction Santo Domingo market. Construction authorized December 14, 1914. Plans prepared by the Bureau of Public Works. Constructed by administration.	
Estimated cost	₱15,016.00
Amount of donated labor	none
Amount of donated materials	none
Amount of donated transportation	none
Miscellaneous	718.19
Labor	1,879.52
Materials	7,527.22
Surcharges	768.58
Total	10,883.51
Liabilities:	
Labor	333.32
Materials	123.00
Surcharges	589.00
Land value	1,220.00
Total	13,148.83
Appropriations:	
Municipal funds	₱2,167.44
Insular funds	15,000.00
	17,167.44
Balance to be used for constructing concrete posts and woven wire fencing, also beautifying grounds	4,018.61

The above mentioned markets would have been completed much sooner, if so much trouble had not been encountered in procuring the land.

The Dolores barrio 4-room school building, project No. 21, has been completed. The following is the history and actual cost of construction.

Project No. 21, construction Dolores barrio school building. Constructed under Bureau of Education standard plan No. 4. Construction authorized March 24, 1914.	
Amount of Insular Funds:	
Act No. 2029	₱5,000.00
Insular Aid	747.69
Amount of local funds	4,400.00
Value of donated materials	none
Value of donated labor	none
Value of donated transportation	none
	10,147.69
Miscellaneous	1,189.30
Labor	1,903.63
Materials	5,742.74
Surcharges	490.54
Insular aid	747.69
Liabilities:	
Surcharges	10.00
Miscellaneous	11.40
Labor	41.50
Materials	10.00
	10,146.80
Balance of funds to be returned to the Insular Treasurer	none

Comment.—This project would have completed much sooner if adequate funds had been provided. The work was stopped several times for this reason. The cost of transportation by rafts from the Port of Pandan to Dolores, a distance of forty-one kilometers, was ₱857.02.

The Tayum school building has been completed and the following is the history and actual cost of the project:

Project No. 32, construction Tayum barrio school building.
Constructed under Bureau of Education standard plan No. 3.
Construction authorized June 23, 1910.

Amount of Insular funds:	
Act No. 2029.....	₱1,000.00
Act No. 1901.....	4,000.00
Insular aid.....	108.55
Amount of local funds.....	3,219.81
Value of donated materials.....	none
Value of donated labor.....	none
Value of donated transportation.....	none
	8,328.36
Miscellaneous	666.80
Labor	2,417.92
Materials	4,419.03
Surcharges	665.04
Insular aid	108.55
Liabilities:	
Surcharges	6.00
Miscellaneous	.90
Labor	43.00
	8,327.24
Balance of funds to be returned to the Insular Treasury.....	none

Comment.—This project would have been completed much sooner if adequate funds had been provided. The cost of transportation by rafts from the port of Pandan to Tayum, a distance of 37 kilometers, is ₱513.47.

The Candon market, an administration project, is 85 per cent completed. All that is needed is the concrete floor. Cost of construction will come under the estimate and appropriation.

Six thousand acacia trees have been planted on the first-class roads in this province, spaced in accordance with instructions from the Bureau of Public Works.

ILOILO.

The Iloilo-Mandurriao-Jaro-Iloilo Loop Road has been completely resurfaced with limestone from Guimaras Island quarry. There is a total distance of 11 kilometers of this new work, completed at a total cost of ₱27,401.14.

Grading on the Barotac Nuevo-Anilao Road has been completed to the Tinorian River, and rolling of subgrade and placing of surfacing have now been started. This road when extended will pass through Banate, Barotac Viejo, Sara and Balasan, connecting at the latter place with the proposed interprovincial road to Pilar, Capiz.

The collapsible deck has been replaced on the Jalaud Bridge. Three new pile bents had to be placed as the former bents were washed out during the floods of August. The total cost of the work was ₱888.87.

The contract of Mr. J. E. Ainsworth for construction of the river wharf was completed on December 20th. This structure is of reinforced concrete on wooden piles, the heads of which are out off below the bottom of the river. The contract unit prices for this work were:

Wooden piles in place per lineal meter.....	₱3.00
Sand in place in fill per cubic meter.....	1.15
Rip rap in place under wharf per cubic meter.....	4.00
Reinforced concrete in wharf per lineal foot.....	140.00
Average cost of completed work inclusive of above in addition to drains, extras and surcharges of 6 per cent provincial and 10 per cent insular, per lineal foot.....	138.92

No rental or depreciation of equipment is included in the latter figure as the contractor was allowed the use of the complete government plant free of charge.

The Molo jetty has been completed for a total length of 510 meters. Due to new current action sand has already begun to be deposited in its rear. From the present indications it is expected that the results will satisfy all expectations. There has been placed a total of 11,082.52 cubic meters of one and two tonne boulders. The contract price for this work was ₱3.50 per cubic meter in place. W. H. Lambert & Co. were the contractors.

A contract has been granted Kilby & Flower for the construction of Kilometers 11 to 14, inclusive, of the Dueñas-Lambunao Viejo Road. They have already started work and expect to be finished during April, 1916.

A first-class road has been constructed connecting Dumangas with Pototan.

A standard type 15.10 by 9.10 meter two-story reinforced-concrete presidencia building has been completed in Dumangas at a total cost of ₱13,608.67.

A contract has been granted J. W. Ford for the construction of a three-span reinforced-concrete pile and girder bridge across the Lub-lub River at a cost of ₱8,058. The work is at present 20 per cent completed.

Transfer of the property for the new street through the nipa district of the city of Iloilo has been completed. There is available

for the construction of this street ₱25,000, being funds allotted by the Insular Government. Actual construction will start January 1, 1916.

It is now possible to travel by automobile from Iloilo to San Joaquin the most southern municipality in the province. Surveys are being made for an interprovincial road connecting San Joaquin with the province of Antique.

A new presidencia similar to that of Dumangas is to be constructed in San Joaquin. The Director of Public Works has been authorized to advertise for bids.

The Janiway municipal building is to be reconstructed. Work is to start immediately.

The construction of the Dingle School, a standard plan No. 7 has been delayed since November 14, 1915 by the nonreceipt of the roofing iron. The district engineer has received no information as to the date of delivery of this iron.

Due to lack of labor and the rainy season commencement of work on the Estancia-Balasan Road has been postponed until January, 1916.

Estimates for the new Iloilo customhouse have been completed and the Government has the second time advertised for bids from contractors, the first bids having been too high.

ISABELA.

Road construction has been suspended since last July, but as soon as the weather permits work will be resumed. Already the regular Bureau allotment of ₱14,257.00 for 1916, the same amount as was allotted for 1915, has been made available. The provincial board has decided to spend the money as follows: Construction Cauayan-Angadanan Road, ₱9,000, construction Ilagan-North Road, ₱5,257.

The construction of a plan No. 7 standard school building for Echagüe will soon be started, as enough materials have already arrived from the Bureau of Supply. The first lot of form lumber, which was ordered from the Nueva Vizcaya saw mill, has already arrived. Said lumber will cost f. o. b. carts Echagüe the same as Bureau of Supply charges f. o. b. boats Manila, which means the saving of the freight charges from Manila to Echagüe.

The 40,000-gallon cylindrical concrete water tank for the Constabulary Barracks at Ilagan has been completed and is now in use.

The construction of the proposed one-story presidencia for Cauayan is still in suspense, although ₱10,000 has been appropriated with ₱5,000 already available, pending the decision of the Municipal Council as to whether they will adopt the one-story or two-stories building. In case of the latter an additional appropriation will be needed.

The typhoon of October 28-29, 1915, damaged the roads of the province about ₱2,000. Repairs will be made as soon as the inclement weather is over. It is stated that, in the last three years, it is only this year that the province has known heavy rains in December. The farmers are predicting good crops of rice and tobacco.

CAPIZ.

The resurfacing of Kms. 1 to 7, inclusive, of the Calivo-New Washington Road has been completed and the road is now ready to handle the motor-truck traffic which will be required to haul the hemp and copra of that section.

The old wooden bridge, No. 4.74 on this road, known as the Caano Bridge has been filled in and replaced by a line of four 60-centimeters concrete pipes. The road was a toll road up to 1912 and the Caano Bridge will be remembered as the site of the old toll house. More than a kilometer of this part of the road is on a rather high fill through a salt marsh. The road ditches furnish a waterway for bancas at high tide. The subgrade floats in very soft muck about 4 meters deep. A concrete culvert therefore would have demanded a pile foundation at a cost out of proportion to the importance of the culvert. A difficult and costly temporary road would also have been necessary to carry traffic over the surrounding muck. For these reasons it was decided to lay four lines of 60 cm. concrete piles, building the head and wing walls on piles. The muck under the roadway was prepared to receive the pipes by packing into it, below low water, horizontal layers of saplings trimmed close and 2" to 3" in diameter. These were well tamped and covered with 10 cm. of the fine gravel. The resulting foundation holds the pipes and fill very satisfactorily.

Materials are now being received for the construction of a 22-meter skew arch at Balucuan on the Dao-Mambusao Road, the collapsible bridges at Dao and Cuartero, and the 10-meter slab-and-girder bridge on the Capiz-Libas Road. Construction will commence immediately upon receipt of the pile driving equipment which is being assembled by the Manila office. The bridge program laid out for 1916 will keep the equipment and two bridge gangs busy throughout the year.

On the Tangalan-Ibajay Road the mountain section from Km. 22 to Km. 28 has been surfaced. The surfacing of 2 kilometers beyond Km. 28 early in 1916 will open up for continuous traffic 44 kilometers of road along the north coast from New Washington to Ibajay.

The Pilar School and the Ivisan School, standard three-room buildings, were 80 per cent completed by December 31. January should see them both occupied.

LAGUNA.

Very little road construction has been done during the past three months. At Los Baños roads into Camp Eldrige, 146 lineal meters, and to the Military Wharf, 76 lineal meters, have been completed. On the San Pablo-Nagcarlan Road, 15.5 kilometers long, the grading has been completed except 300 meters and the surfacing except 4.8 kilometers. The subgrade that is left unmetalled is of such character that it stands up fairly well under traffic and the road will be open to traffic by January 15.

The baguio of December 7 damaged the roads and bridges of the province to the extent of about ₱50,000 mostly on bridges lost or badly damaged. High-water marks heretofore undreamed of are being set at the site of practically every bridge in the path of the typhoon.

Three groups of 5, 9, and 12 tiendas each are under construction at San Pablo. The group of 5 is of the open tienda type while the other two are of the standard single type. The work is being done by administration and the funds available are ₱29,000.

A No. 4 standard Bureau of Education plan school house is being constructed by administration at Bay and is nearing completion, all the concrete work having been finished and the roof placed.

Requisitions have already been made for the material of a No. 7 standard Bureau of Education plan at Alaminos, and work on same by administration will be started soon.

There has been very little activity in the operation of the Los Baños Quarry the past three months owing to a falling off in the demand. New machinery consisting of a 65-horsepower crude-oil engine and a No. 5 Telsmith gyratory crusher have been ordered, and will probably be received in time for use during the coming dry season. The output for the quarter ending September 30 was 5,003 cubic meters while that for the quarter ending December 31 will probably not exceed 2,000 cubic meters.

LANAO.

It was necessary to discontinue the Iligan-Overton Road construction owing to the lack of funds. All temporary bridges on this project have been replaced by permanent structures.

The Lanao Public Hospital has been completed with the exception of the painting, which was postponed until the change of the monsoon on account of the numerous gnats that blow shorewards from the lake. The gnats would stick to the wet paint and would cause an unsightly appearance. They are so numerous at times that an ordinary petroleum lamp becomes extinguished and a person venturing into a brilliantly lighted room finds it extremely difficult to breathe without inhaling gnats at every respiration.

Work on the Tamparang-Kabaritan telephone and trail has been temporarily suspended. Sixteen kilometers of telephone line is completed.

The new Dansalan wharf and breakwater has been started. It consists of a stone pier to be extended for 35 meters to serve the double purpose of breakwater and wharf.

The piling of the Ganassi wharf has been driven, and decking will be started in the near future. The driving of the Lumbatan wharf piling has been started. Tamparan will be the next project to be undertaken.

A maintenance gang has been placed on the Dansalan-Ganassi Road and all temporary culverts have been replaced by permanent ones. The road is now open for traffic to Km. 16.

A good example of the desire for roads has been shown by the people living on the north coast between Iligan and the Misamis Province boundary. Last October some 400 men petitioned the district engineer to be allowed to clear a right of way and to construct as much road as possible during a period of four days, which was to be the voluntary time offered by each individual; but as is usual only about one-fifth of the labor materialized. However, the entire distance from the Mandulug River to the boundary line has been cleared and all streams except the Mandulug River have been bridged. An appropriation has been made for 1916 for the construction of this road. This will connect with the road from Cagayan and will be a continuous road from Dansalan, Lanao to Cagayan, Misamis, an approximate distance of 125 kilometers.

Estimates are being prepared for the construction of a concrete road 1,500 meters long from the Keithley Road to Dansalan. It is estimated that while the initial cost may be more than that of a

metal surfacing, a great saving over the metaled road would be made in the maintenance, for the road is subjected to extremely heavy traffic and to almost constant heavy rains.

The military authorities have commenced the resurfacing of the Overton-Keithley Road under the direction of Major Williams, commanding officer, Camp Overton. Lieutenant Carter is in charge of the project.

LA UNION.

The subgrade work has been started on the Caba-Aringay section of the Manila-North Road, and about 2 kilometers of it were completed by January 1. The work was begun at Km. 23, leaving Km. 22 in the poblacion of the town of Caba to be relocated in accordance with the circular letter of the Acting Secretary of Commerce and Police dated August 7, 1915. The writer believes that the suggestion given in said circular is a very wise one, as it will eliminate the dangerous feature of fast-going motor vehicles in thickly settled localities, which are generally the poblaciones of the towns in this country, and will keep away from such places the source of dust which is great on the main roads. The original location of said road through the above-mentioned town passes close in front of a modern schoolhouse, and the proposed relocation will take it quite a distance behind the building at the eastern edge of the poblacion. The original location at the Aringay end also passes through the center of the poblacion and close in front of the Catholic Church. A relocation here is also proposed at the eastern side of the poblacion to connect with the tangent passing through the center line of the proposed bridge-site at Aringay River. The new location will eliminate the right-angle turn on a street in the poblacion connecting with this tangent, a turn where the "safe sight distance" is very much reduced by the big church itself.

An Insular allotment of ₱30,000 has been made for the construction of the cut-off from the barrio of Damortis to the barrio of Concepción, the mountainous section of the Caba-Camp One Road project. The survey of this road has just been completed, and plans and estimate are being rushed so as to include the project in the 1916 budget.

The long ferry across the Busilac River on the Luna-Bangar Road, which has been the source of much worry to the travelers in a big hurry, can now be forgotten, as the new first-class road between Luna and Bangar via Balacan is open for traffic.

The collapsible bridges on the Bauang and Naguilian Rivers have been replaced since December 1, 1915, and the automobile lines to Baguio and the northern provinces are again connected with the railroad at Bauang Sur Station. Both of these bridges went out in the typhoon of last October, the Naguilian bridge suffering the most, having lost two concrete-filled steel pipe bents and one wooden bent, while some of the remaining bents were badly twisted. While the Naguilian Bridge was out and the river still high, the aerial ferry was put into operation.

The keeper's residence at the San Fernando Point Light Station, which was slightly damaged in the October typhoon, has been repaired, with additional improvements to the cisterns and bodegas.

The construction of Bauang market has been completed at a cost of ₱14,851.42 including the purchase of the site. The building was inaugurated with a *baile* in the building itself.

Concrete tables and ticket booths are being installed in the finished markets of San Fernando and Naguilian. The tables are occupied as fast as they can be made, the sellers greatly preferring them to the floor.

LEYTE.

The surfacing on the Palo-South Road has been laid to Km. 66.8. The work has been greatly delayed by breakdowns occurring to the locomotive, which have made it again necessary to do the hauling by having men push the cars on the tramway. As the haul is now 9 kilometers the work is progressing at a slower rate than formerly, anyway.

Heavy traffic of the iron-tired truck variety has damaged the Tanauan-Dagami section of the Palo-South Road so much that it has become impassable in three places in spite of every effort to keep it in shape. The maintenance work was also interrupted by the flood on December 6 and 7 which carried away the wooden bridge to the Kawayan Quarry thus making it impossible to get stones for this section for ten days. Trucks designed for loads of 5 tons are passing over this road loaded with 100 sacks of rice (6.25 tons) and hauling trailers loaded with 50 sacks each. Also 1½-ton passenger trucks are carrying 50 to 60 people each, making a load of 2½ to 3 tons, or about double what the cars are designed for. There was no sunshine for the first week in December, and the heavy rains so thoroughly soaked the subgrade that there were dozens of subgrade failures between Km. 22 and Km. 30 of the Palo-South Road. This iron-tired traffic has been recently introduced on the Carigara Road, which until now has been in excellent condition, but the same effect is

evident here as on the Palo-South Road, although this road is supposed to have been much more strongly built than any other Leyte road.

The results here would seem to prove conclusively that no 6-inch or 8-inch macadam road can withstand the type of traffic to which our roads have been subjected for the past fourteen months. During the past year the province has spent, in round numbers, ₱175,000



Driving 11-meter pile, Ugayong Bridge, Bato, Leyte Province.

on resurfacing and maintenance, which is about double the appropriation of any previous year, the approximate maintenance costs per kilometer being as follows for the past four years: 1912, ₱867; 1913, ₱870; 1914, ₱765; 1915, ₱1,508.

There are some kilometers of the Tanauan-Dagami Road on which the maintenance ran as high as ₱3,000, while the Carigara Road, on which no iron-tired trucks were in operation, averaged about ₱800 per kilometer.

The concrete work on the Mainit Bridge was completed during the first week of November, and the work of assembling and riveting the steel superstructure is now in progress.

Work has been started on the Naval School, a standard Bureau of Education Plan No. 7 situated at Naval on the Island of Biliran. The estimate for this work is ₱15,547.10, but as there is only ₱10,067.40 available it has been determined to omit windows, doors, ceiling and partitions for the present. Considerable credit is due to President Justiniano Garcia of Naval and to the members of the Naval council



Plaza at Malitbog, Leyte.

for the manner in which they have helped the district engineer in every way possible in all matters connected with this project.

Work on the Tabontabon School has been postponed pending final tests of the sand and gravel available. Cubes made from this sand and gravel have given very unfavorable results.

Work was recently started on the Albura School (plan No. 2) by administration. It is expected that the building will soon be ready for occupancy.

Owing to the delay in receiving materials for the Ormoc and Hilon-gos markets, work was not started until November 22 on the Ormoc market and December 20 on the Hilongos market. Both jobs are now being pushed to completion as fast as possible.

The following concrete-pile bridges on the Maasin-Inopacan Road have been completed by administration:

Names.	Sizes.	Esti- mates.	Costs. ^a
Ugayong Bridge	Three 7-meter spans	₱9,500	₱7,700
Punong Bridge	Four 7-meter spans	11,200	9,000
Cang-Iglang Bridge	Three 7-meter spans	8,800	6,800
Labo-on Bridge	Two 7.5-meter spans	7,200	5,600

^a Cost includes approaches and metaling while estimate does not.

The soft nature of the soil at these bridge sites necessitated the making and driving of 12 extra piles, and the lengthening of some by as much as 1.5 meters, all of which naturally increased the cost. It will be observed that these bridges, although situated in an extremely isolated locality, were completed at a cost of less than ₱345.00 per linear meter including approaches and making and driving extra piles. Some of the cement was received in iron drums which were utilized for forms, the iron being readily bent to the necessary shape for use in place of sheathing for the girders.

The Taghaligue Bridge at Km. 25.8, Maasin-Inopacan Road, a standard 9-meter reinforced-concrete deck girder span on U abutments without piles, has been completed. When the excavation was finished the foundation appeared soft and a test was made. A load of 2.5 tons per square foot was applied, which resulted in a settlement of only $\frac{3}{32}$ of an inch in twenty-four hours. This was considered satisfactory, as the bearing called for by the plans was 1.8 tons per square foot. The bridge cost ₱5,200 including approaches, and its estimated cost excluding approaches was ₱5,700. It was also done by administration.

During the past year the total amount of appropriations for work under the District Engineer's office amounted to over ₱600,000, of which about ₱500,000 was expended between January 1, 1915, and December 31, 1915.

The recent increase in the cost of materials and freight rates has necessitated a revision of market and school estimates for the coming year.

MINDORO.

In the repair of the Calapan dock the framework of a jet well rig is being used for a derrick. A piece of 2½ by 2½ by ¾ inch angle was bolted horizontally to bottom of guides, and reinforced with a 3 by 4 inch piece of wood. In the center of this horizontal piece an inch hole was bored, into which was set a Y-yoke bolt having a ¾-inch hole bored through the sides of the yoke. A long steel eyebolt was bolted into the Y yoke and the long end inserted into a 3-inch plugged wrought-iron pipe, consisting of two 10-foot lengths coupled with a standard pipe coupling, forming a boom nearly 7 meters long, having about a 5-meter reach and a swing of 90°. The boom is held by a ¾-inch cable passing through an eye in the top of the pile driver guides and back over the frame to the bottom where it is fastened with Crosby clips, thus anchoring the boom at the rear of the pile driver. The guides are also anchored by the cable laterally, and the whole is weighted down by large stones. From the end of the boom is suspended a 2-ton differential hoist for lifting the larger stones, which weigh from ½ to 1 ton. A pair of scissor hooks were made to hold the large stones while being lifted into place, for when small grip holes were made in the stones, the scissor hooks were found far more satisfactory than plane slings, because it was necessary to roll stones on the latter, and it took considerable time to roll them off when deposited. With the scissor hooks, stones can be practically placed where desired within swing of arc.

The Provincial Board has approved the construction of the Calapan water system by administration. The pipe has been ordered and work on the intake will be begun as soon as the dry season sets in.

The work on the Calapan-Dock Road has progressed very slowly, but is practically finished. The typhoon of December 6th and 7th did considerable damage on Km. 2. A piece of the sea wall on Km. 1 was also washed out. About 500 meters of the edge of the road just outside the ditch line on Km. 2 was washed away, thus exposing the road proper to the next storm that comes. It will be necessary either to pile large rocks or build a wall along this part of the road to protect it from further encroachment by the sea. Some 400 meters of Km. 1 were covered with sand by the waves to depths varying from 10 to 30 centimeters.

Work on the surfacing of the Calapan-Jolo Road was progressing nicely until the last typhoon when the rainfall was so great the

road bed was soaked up to such an extent that it would not bear the weight of a road roller. Practically no work could be done for two weeks.

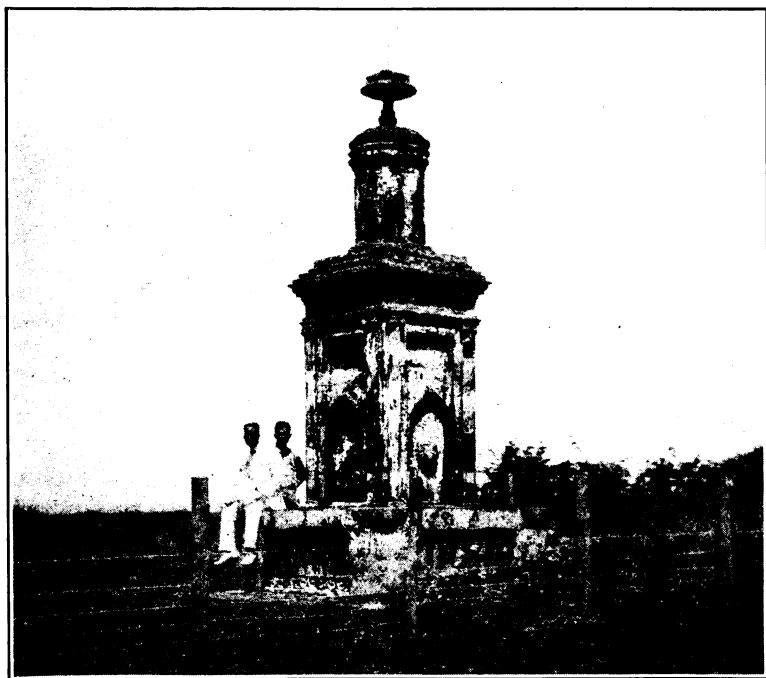
The work on the Naujan School was delayed considerably because all the reinforcing steel had not been received, but it is now on the ground, and with no further delay the school should be done by the first of March. Practically all the materials for the Pinamalayan School are on the site, and work will be begun at the beginning of the year.

MISAMIS.

The public spirit shown by the municipalities of Misamis Province is certainly commendable. Balingasag, an isolated but progressive municipality on the east coast, has recently appropriated from municipal funds the sum of ₱8,200.57, the estimated cost of a hydraulic-ram water system to consist of two rams, one tank, 2,650 meters of 1½-inch and 2,225 meters of 2-inch main pipes, with provision for house connections and four public service hydrants. The source of the water is in the Luguimit Spring, situated 500 meters north of the town and 250 meters west of the Cagayan-East Road. The chemical analysis shows:

(Numbers give parts per million.)

Physical characteristics: color.....	nil
Reaction: alkalinity as CaCO ₃	58.7
Total hardness.....	93.0
Total solids.....	149.5
Total silica (SiO ₂).....	45.0
Sulphuric acid radical (SO ₄).....	29.2
Bicarbonic acid radical (HCO ₃).....	71.7
Carbonic acid radical (CO ₃).....	nil
Chlorine (CL).....	4.6
Iron (Fe).....	0.2
Calcium (Ca).....	24.3
Magnesium (Mg).....	7.8



Spanish fountain, Balingasag, Misamis, built 1891.

There is an artistic water fountain on the public square opposite the municipal building. This fountain was designed and erected in 1891 by the Jesuit Father Salvador Ferrer, and remains to this day in perfect condition.

The municipality of Misamis has appropriated from municipal funds the sum of ₱8,000 for a municipal building and ₱2,500 for a market building. All other municipal funds available were appropriated for the continuation of the road and bridge work on the Misamis-North Road, a provincial project participating with an Insular allotment.

A total of ₱19,837.48 has been appropriated for the Misamis-North Road this year, of which ₱10,000 are Insular, ₱4,900.00 municipal and the balance provincial. Oroquieta appropriated ₱3,500 for this road; Jimenez ₱900; Misamis ₱500, and Plaridel all labor and materials for a 90-foot wooden Howe truss bridge over the Plaridel River, approximate value ₱5,000. The municipality of Jimenez also appropriated ₱1,000 municipal funds and ₱2,000 voluntary contribution for the Jimenez Bridge on this road.

The Oroquieta Ferry is now complete and in operation.

The municipality of Jimenez has requested a loan of ₱10,000 for a new Municipal Building.

All the projects here noted are administration projects.

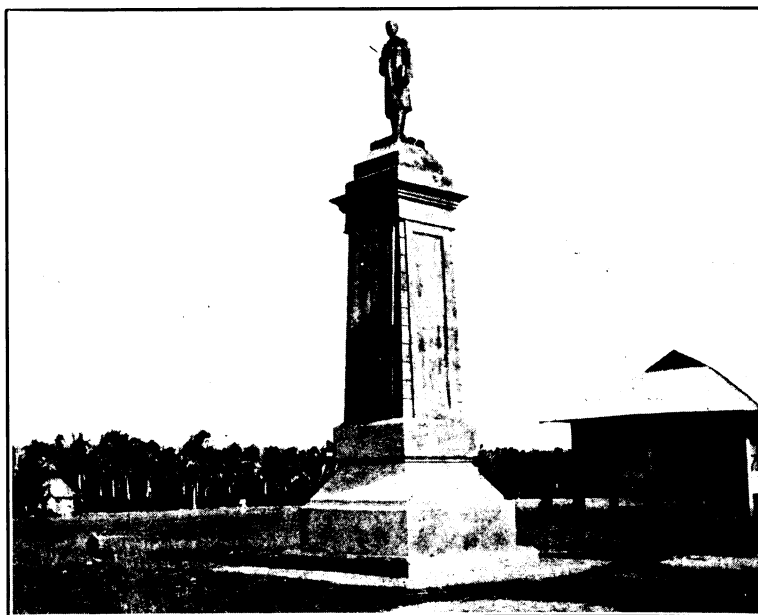
The Camiguin Island Circuit Road has been opened for traffic from Mambajao to Catarman, making a total at this date of 26.5 kilometers.



Oroquieta Ferry, Misamis.

meters of first-class road, 20.5 kilometers second class, with 10 kilometers of trail remaining to be converted into road to complete the drive around the island.

The municipality of Sagay, Camiguin Island, has appropriated all available funds in furtherance of these plans, the municipality of Mambajao having diverted all its available funds to the problem of school construction and a Rizal Monument. The other remaining municipality, Catarman, has appropriated all available funds to the furtherance of a reassessment of the land tax, but not without having fully demonstrated a thorough interest in public works with volunteer labor.



Rizal Monument, Mambajao, Camiguin Island, Misamis.

BUKIDNON.

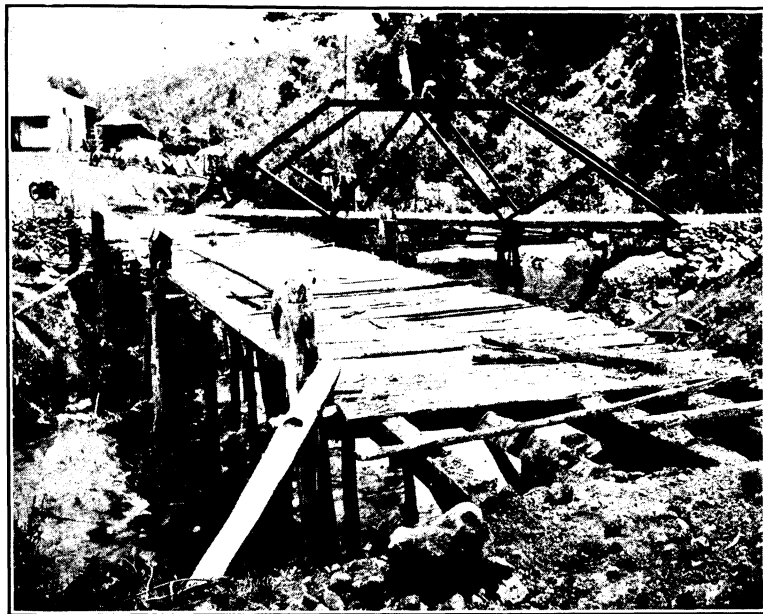
The Diklom Bridge has been recently completed. It is a wooden truss of 65-foot span.

A ferry, similar to the Oroquieta pattern and to cost ₱1,000, is projected for the Cagayan River crossing on the Cagayan-Talacag

Road. The ferry is to be operated across a small pool in the river, known in the native dialect as *mig-buayá* meaning, "Here are alligators."

NUEVA ECIJA.

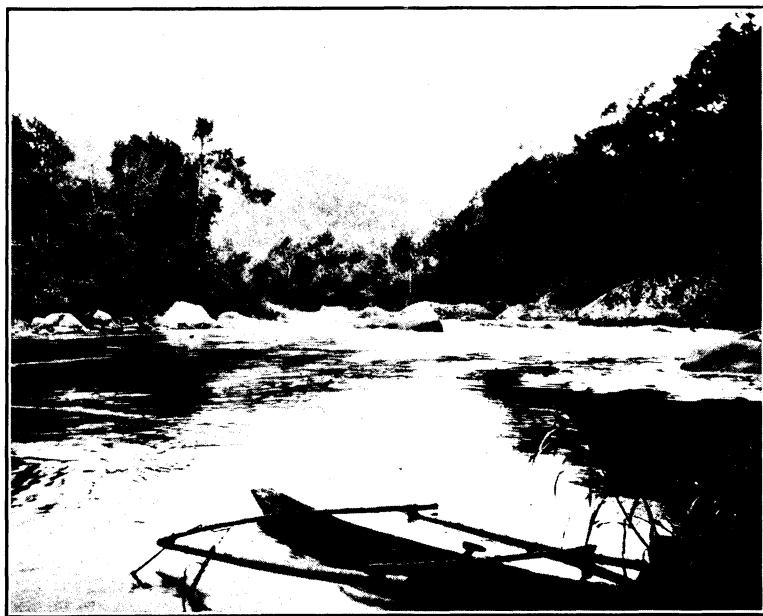
Owing to excessive rains and floods there has been no road construction in the province during this quarter.



Diklom Bridge, Bukidnon, under construction; 65-foot span.

Maintenance of first-class roads has been the most difficult project. More than half of the first-class roads have been under water three times during this quarter. The binder has been washed out in many places, and the road bed covered with sediment from 10 to 30 centimeters deep. Our method of handling the maintenance on overflow sections is to remove the sediment as soon as the water goes down and before the sediment hardens. If the sediment is allowed to harden on the surfacing, the latter will be removed with the sediment, or else the road will be unusually dusty when it gets dry.

The senior inspector's quarters in Cabanatuan have just been completed and turned over to the Bureau of Constabulary.



Site for ferry installation, Cagayan River, Bukidnon (downstream view).

A standard plan 15 by 39 meter market building has been completed at Peñaranda and turned over to the municipality. Mr. M. E. Martin was the contractor and completed the building in ninety days. Contract price, ₱9,530.

A standard plan 15 by 39 meter market building has just been completed at San Isidro. The Manila Lumber Company was the contractor and completed the building in 120 days. Contract price, ₱8,420.

The contract for a standard plan 18 by 38 meter market building for the municipality of Guimba, Nueva Ecija, has been let to E. T. Yu Chenco for the sum of ₱10,600.

A survey and estimate has just been completed for a road connecting the municipalities of Licab and Santo Domingo with the Manila-North Road, just north of the Talavera River. This road will furnish an outlet to the most productive municipalities in the Province, Licab being one of the oldest as well.

The collapsible bridge at Gapan on the Manila-North Road, has just been replaced and the entire North Road in this province is now open for automobiles and other traffic.

OCCIDENTAL NEGROS.

The subgrade work on the Victorias-Manapla Road has been completed and the road is now open to traffic. About 2 kilometers of road are surfaced and about 2 kilometers more have first and second course gravel delivered on the road ready for spreading and rolling. Hauling of gravel is being done by bull-carts or by tramways, and with the two road rollers now at work, one in Manapla and another in Victorias, the surfacing will be completed before May, 1916. Through traffic is now possible to Cadiz in dry weather and by January 15 ferries will be operated at the Sicaba and Talaba-an Dacu Rivers.

The construction of twenty culverts on the Victorias-Manapla Road has already been completed and the structures turned over to the province. The three 13-meter arches are also completed except the balustrade posts.

Bids on the Pontevedra Bridge over the Marayo River on the Pontevedra-La Carlota Road were opened on December 21, Mr. J. W. Ford of Iloilo being the lowest bidder. The district engineer's estimate of cost was ₱19,160.64 and the bids were as follows: J. W. Ford, ₱19,720; W. H. Lambert, ₱21,500; A. Buchanan, ₱22,223.25. Contract has been awarded to Mr. Ford and work will be completed within a few months.

The Isabela-Nalibay Road, just completed, has been recommended for designation as first-class road. It is 2.7 kilometers long and up to date has been carried as second-class road. It has been resurfaced at a cost of ₱2,500 and now is one of the best roads in the province.

Progress on the Biniquil-Kabankalan Road has been rather slow; continuous rain and scarcity of labor being the causes for this delay. It is expected that with two months of good weather its completion will be assured.

Grading on the Himamaylan-Biniquil Road for a distance of 8.5 kilometers is done by "paquiao" and is progressing satisfactorily. Of this distance 4 kilometers have been completed. Gravel delivery is moving rapidly and surfacing of this section will be started as soon as a road roller is available.

Work on the Kabankalan-Ilog Road, 6.5 kilometers long has begun. Contract for delivery of gravel for this section has been let to Mr. Ramon Coscolluela, a prominent *hacendero* of Ilog. Deviation from the old road has been deemed necessary in order to obtain a better alignment. There will be only three curves on this road.

Contract for the construction for the Bacolod market building, a 24 by 42.80 meter type "B" has been let to Mr. Monico Puentevella, local contractor, for ₱17,280 complete. It is expected that work will be started within a week.

The construction of Maa market building standard type, was re-advertised. The bid of a Manila contractor was the lowest, but he refused to sign the contract, and the construction has been recommended to be done by administration.

The pumping station and water supply for the provincial high school will be installed as soon as all the materials are ready. A Fairbanks-Morse 5 by 5 inch Typhoon Pump geared to a 2-horsepower engine has been purchased for this purpose. A tank on a 40-foot tower will be erected to distribute the water.

The San Carlos-South Boundary Road is almost completed. This will connect with a good road being built by Don Diego de la Viña of Valle Hermoso, Negros Oriental.

ORIENTAL NEGROS.

Work has been started on several small culverts on the North Road in the town of Vallehermoso. The section of trail from Vallehermoso north to the provincial boundary is being widened and graded by hacienda laborers, the province furnishing only dynamite and a man to use it.

Contract work on the Larena intermediate school, a number seven building, was completed on November 28. Owing to shortage of available funds the interior ceiling and partitions were omitted. Additional funds are now available, materials have been ordered, and work will be begun as soon as they arrive.

Subgrade work on the Maria-Campalanas Road in Siquijor is completed. This section is 18.5 kilometers long and cost approximately ₱7,500. The old road, which in places was little more than a trail, was widened out and the steep grades cut down. The funds remaining are to be expended in repairing old wooden bridges, building pipe culverts and placing surfacing.

Four successful artesian wells have been lately completed in the province, two in Sibulan and two in Ayuquitan. One more is to be drilled in Ayuquitan.

Contracts have been awarded for the Bais Bridge. Structural steel is to be furnished by the Atlantic Gulf, and Pacific Company of Manila, Mr. C. V. Powers of Dumaguete has the contract for constructing the substructure and erecting the superstructure. The bridge is to be an 80-foot pony truss on concrete abutments with pile foundations. This is the only bridge remaining to be built from Dumaguete to Km. 53 of the North Road. Construction was commenced during the latter part of November and the work of driving piles will start within a few days.

Continuous rains during the past five months have greatly interfered with road construction, making the use of road rollers impossible a large part of the time. The cost of maintenance has also been increased.

On the Bais-Tanjay Road surfacing has been completed to Km. 38 south of Bais and nearly to Km. 50 north. All grading has been



Camineros, Dumaguete-North Road, Oriental Negros.

completed except the approaches at bridge 45.8. In Kms. 51 and 52, 1,600 lineal meters of road through the swamps of Panambalon River have been rippedap with coral rock.

A full set of sanitary concrete tables is being constructed in the Guijulan market building.

Four concrete tables have been built in the Dumaguete market. A 500-gallon tank on a 40-foot tower was erected for a water supply for washing up.

PAMPANGA.

The surfacing on the Manila-Tarlac Road, San Fernando-Angeles section, is almost completed except about 50 meters (one side only) on the San Fernando end pending the solution of some right-of-way questions. The practice has been not to build the road on the side where opposition to granting the right of way was encountered, and this practice gave excellent results. This road was opened to traffic the middle of November. Its use was in great demand, as it connects the commercial center, Angeles, to the capital, San Fernando. The entire road of about 17 kilometers does not require a single bridge. The irrigation ditches were taken care of by concrete pipes made from cement drums. At the Sacal Creek a double 2.25-meter diameter reinforced-concrete pipe with a 15-centimeter shell was constructed. The pipe cost about ₱1,000.

The municipality of San Fernando deposited the sum of ₱2,500 with the provincial treasurer and work was started December 16 on the surfacing of Calle Maura.

The resurfacing of the Angeles-Porac Road has been completed and the grading of shoulders and slopes will soon be finished. The Pasig River, which crosses this road, has changed its course, now crossing it nearer Porac. Due to the uncertainty of the Pasig and

to the gradual rising of its bed no work has been done to control it. The traffic was in no way stopped since the river is fordable at the new crossing. The Guagua-Lubao Road, 7 kilometers long, is now of standard 15-meter width, the right of way having been ceded willingly by the adjoining property owners.

The grading and widening of shoulders and slopes on the Apalit-Macabebe Road has recently been started and is being made at a cost of about 25 centavos per lineal meter of road.

In spite of the fact that the Pampanga River rose considerably during the past typhoons, the Arnedo Dike stood without needing any important repairs.

The San Fernando Central School (plan No. 20 less 4 rooms) is about 90 per cent complete. Some of the partitions, balustrades, and painting still remain unfinished.

The Sexmoan School (plan No. 4) is nearing completion.

The Magalan School (plan No. 6) is almost finished but pending the arrival of materials from Manila it will probably not be inaugurated till the 6th of January, 1916.

The Baruya Barrio School (plan No. 3) was completed November 29, 1915, at a total cost of ₱7,289.78. This building was considerably delayed due to the lack of galvanized iron roofing and to the difficulty of transportation, Baruya being an isolated barrio of Lubao. This was the only contract work done this year and the contract price was ₱6,500.

The funds for the additional permanent market building of Guagua are almost exhausted. Due to the limited amount, only about a fourth of the market can be completed.

The standard market tables for Guagua are about 60 per cent completed. These are the first standard market tables built in the province, but it is expected that the example of Guagua will soon be followed by other towns.

The plans for the roof of the municipal building of San Fernando have already been received. The materials have been requisitioned and work will begin upon their arrival.

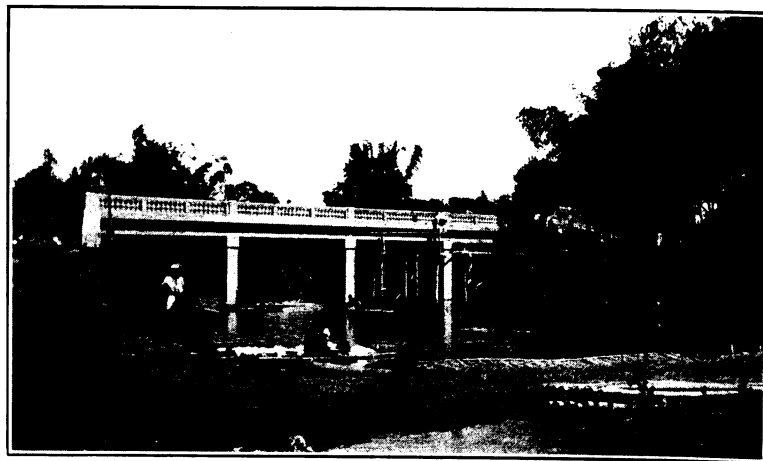
The Municipality of Mexico has almost completed arrangements for the repairing of the road leading to the station from the Provincial Road and several months ago asked the Manila Railroad Company for free transportation of the rock from Arayat quarry to Mexico. Up to this time no answer has been received. The station is located about a kilometer from the municipal building.

PANGASINAN.

The following school buildings were completed and dedicated during the past quarter: Modified plan No. 10, Alaminos, cost, ₱22,496.09; plan No. 6, Bolinao, cost, ₱12,519.72; plan No. 10, Umingan, cost, ₱19,515.05.

Work has been started upon a standard plan No. 10 school building, built of timber, at San Nicolas.

Materials have been received for a standard plan No. 10 at Villasis, work to be started on January 1, 1916.



Banila Bridge, No. 185.2, Manila-North Road, Pangasinan Province.

The Banila Bridge, a 5-span reinforced-concrete pile-and-girder structure, skew plan, was completed on December 20 at a cost of ₱11,000, and is now opened for traffic.

The Rosales market, Type "A" 24 by 52.2 meters, was completed and accepted December 1, 1915.

The high water of October 29 washed out 1½ kilometers of the Alcala-Bautista dike, and caused considerable damage to the surfacing of first-class roads throughout the province.

A survey of the Asingan-San Manuel, Mangaldan-San Fabian and San Jacinto-San Fabian Roads was made during the past quarter.

The Tayug-Natividad and Tayug-Santa Maria Roads have been reconstructed and declared first-class roads.

Investigation is being made regarding the improvement of the Tayug-San Nicolas-Nueva Vizcaya Boundary Road.

The contract for the construction of the Manaoag market, Type "B," 21 by 36.1 meters, given to Jones & O'Toole of Dagupan, time for completion 120 days, is as follows: For construction of market building, ₱13,156; for construction of market tables, 2,100; for extra fill and grading, ₱0.40 per cubic meter.

Surfacing and grading on the Dagupan-Bayambang and the Rosales-Umingan Roads was continued during December. Projects suffered during this month from a shortage of labor. All available men, women and children were busy gathering a bumper rice crop.

A temporary bridge was constructed across the Agno River, coconut piling being used with timber floor, so constructed that the lumber of the floor can be salvaged when washed off the piling by high water.

RIZAL.

Extensive improvements to the provincial grounds at Pasig have been made during the course of the past year. The retaining wall along the Pasig River has been increased in height with large rock secured from the old Spanish pier near Angono. This has not yet been entirely completed due to lack of funds. The washout in the grounds caused by the floods of 1914 was repaired early in the year. The cost of these improvements has been a little over ₱1,000.

Title has finally been secured by the Province to certain pieces of ground occupied by the Mariquina Diversion Road which was constructed in 1914.

The telephone system which has been installed has cost about ₱5,500. It is now completed. All municipalities and the Constabulary post at Novaliches are connected to the system.

Additional improvements have been made at the Taytay School, which was occupied early in October. The grounds have been graded and concrete steps and walks have been built.

The Parañaque schoolhouse, a 4-room standard plan with 2 additional rooms has been completed and turned over to the Bureau of Education. Dedication exercises were held in this building on December 19. The total cost of the project was ₱13,100. The municipality is securing title to land to be used as an approach to the school. This street will be about 400 meters long and will be of standard cross section. It is to be constructed by the district engineer early in 1916.

The Navotas market has been completed by John Gordon, contractor. This is an 18 by 38 meter standard plan market. The contract price was ₱10,650. Standard plan market tables, 0.90 by 6.42 meters, have been installed by Gregorio de Silva, contractor. These tables consist of 12 vegetable tables with wooden tops, galvanized-iron covers, and galvanized-iron pipe racks; 4 concrete meat tables with galvanized-iron pipe racks; 8 concrete fish tables with galvanized-iron pipe racks; and a standard ticket booth. The contract price for these was ₱2,100. The total cost of the project including surcharges, inspection and filling, which last was done by administration, was ₱14,161.68. It is planned to drill an artesian well during the coming year, and to install sanitary midden sheds.

The Pasig provincial high school has been completed and formally accepted by the provincial board. It has been occupied since November 6, but was not formally inaugurated till December 18 in connection with the Provincial Garden Day and Baby Show. This building is a modified standard plan 20-room school. The Bureau of Education standard plan was altered by the Consulting Architect so that it would be more compact and allow of easier construction. All exterior walls are straight except the front wing which projects to allow for a large portico. This wing is considerably higher than the remainder of the building, and gives dignity to the approach by its heavy concrete columns and arches. The whole wing is occupied by a large assembly room, having a metal ceiling. All galvanized iron on the roof was given three coats of Deco paint, a priming coat and two red top coats. Semi-indirect lighting fixtures have been installed in the assembly room and office. All class rooms, corridors, and portico are illuminated under the direct system. The contract price for the building construction was ₱58,589.55. Contract price for the lighting installation was ₱2,287.50. The total cost of the project including surcharges, inspection and drainage, but exclusive of the site, was approximately ₱66,000.

The roof of the Antipolo market, which is Apollo brand galvanized-iron and was rusting badly, has been painted with two coats

of Graves metallic paint after a first coat of Deco primer. The roof of the Antipolo schoolhouse will be painted in the same manner as soon as dry weather sets in.

Hand-sawed lumber is being purchased in the municipality of Montalban for the repair of its central school, which is of timber construction. These repairs will be started early in 1916.

Repairs costing approximately ₱1,000 are being made to the officers' quarters of the Constabulary post at Santolan.

Contract for the construction of three bridges on the Angono-Binangonan section of the Manila-East Road has been awarded to the Atlantic, Gulf and Pacific Company. The cement and steel for these bridges have already been furnished by the province. Construction will begin early in January as soon as the present high level of Laguna de Bay recedes. These bridges will cost approximately ₱50,000, and will be the chief construction project of this province for the coming year.

Construction on the Manila-East Road has been completed as far as Cardona, Km. 40.2. This road will be continued during the coming year to the beginning of the second-class road at Km. 50. Traffic will then be able to get as far as Pililla, Km. 57. Surveys and profiles of the section between Kms. 40 and 50 are now being made, and construction will begin early in January. The line follows the old Spanish road, changes being made only to eliminate bad grades and curves.

The provincial board plans to continue the first-class section of the Manila-Mariquina Road from its present terminus at Km. 9 as far as Mariquina, Km. 16.4. It is also planned to build 8 kilometers additional first-class road to the barrio of Novaliches on the Manila-San José inter-provincial road.

The following roads have been designated first-class as of December 31, 1915, an increase of 11.7 kilometers since June 1915, and an increase of 20.8 kilometers for the year:

	From kilome- ter—	To kilome- ter—	Length.
			Km.
Manila-North Road	6.70	13.83	7.1
Junction-Malabon	9.20	11.40	2.2
Junction-Golf Club	9.20	9.73	0.5
Manila-San José	5.32	10.00	4.7
Manila-Mariquina	6.55	9.25	2.7
San Juan-San Felipe Nery	6.92	9.62	2.7
San Juan-Santolan	7.50	8.08	0.6
Manila-East	3.78	40.17	36.4
Pasig-Taguig	11.47	16.04	4.6
Calle Real, Pateros	13.56	13.85	0.3
Junction-Montalban	15.25	35.16	19.9
Taytay-Antipolo	21.05	27.01	6.0
Antipolo-Station	26.90	27.56	0.7
Manila-South	3.34	31.06	27.7
Passay-McKinley	4.98	10.78	5.9
Junction-Zapote	15.00	15.50	0.5
Total			122.5

During the year construction of first-class streets in the municipality of Passay has been carried on to the extent of ₱5,500. The streets are mostly 3-meter surfacing with about 3 inches of Talim Island crushed stone. Maintenance of the streets completed during the past two years in this municipality amounted to ₱2,000 in 1915.

Thirty-three successful artesian wells have been completed during the calendar year in various municipalities of the province. This is only about half of the number planned, and it is now believed that a sufficient number of artesian wells will not be completed till the end of the calendar year 1916.

Public works expenditures in Rizal for the year 1915 will amount to about ₱305,000. Expenditures to the end of November are ₱286,230.40 divided as follows:

Road and bridge construction.....	₱73,478.71
Road and bridge maintenance.....	100,935.71
Building construction and maintenance.....	104,360.27
Miscellaneous	7,455.71
Total	286,230.40

SAMAR.

Repairs to the Constabulary barracks have been completed.

Culvert construction on the Sulat-South Road has been suspended. The work accomplished consisted of three 1 by 1 meter and two 2 by 1 meter standard culverts and one temporary bridge of yacal.

The Balangiga School (plan No. 3) was completed by administration on November 3 at a cost of ₱8,391.37. This included the cost of two standard-concrete closets costing about ₱400 each.

Materials have been ordered for standard concrete closets for the Catubig and Catarman standard schools. Funds are also available for standard closets for the Laoang, Bobon, and Wright schools.

The 5,000-gallon concrete rain-water tank at Laoang is completed. Trus-Con waterproofing paste was used in its construction.

Standard tables in the Calbayog market have been completed by administration, 24 vegetable tables, 2 meat and 2 fish tables each 9.50 meters in length having been built at a cost including surcharges of ₱2,500.00.

The Borongan Central School (plan No. 10) is being advertised. As the only bids expected are for labor only, requisitions for materials are ready for immediate transmittal to the Bureau of Supply.

The Catbalogan High School (plan No. 20, Pasig type) will be advertised at once, it having at last been definitely decided to use the funds available for a high school instead of a provincial government building.

Constantly recurring slides on the Catbalogan-South Road due to typhoons finally brought advance construction to a stop on December 6 and the balance of funds available has been used in reopening the road for vehicle traffic. The road is open to Km. 5.3. The discovery of a suitable quarry site within 100 meters of the road in Km. 3, heretofore unsuspected on account of dense vegetation, has solved the problem of surfacing this section of the road. A spur line has been graded to the quarry site and tramway will be installed and put in operation soon after the first of January. It is hoped that funds will be available for the purchase of a rock crusher, otherwise the rock will be broken by hand.

Since the commencement of construction on the Catbalogan-North Road on September 2, 7 kilometers, including 3 on which work was very heavy, have been completed in spite of the excessive rains. Subgrade has now been completed and the road is open for traffic to the large barrio of Silanga at Km. 10. The work was suspended for this year on December 23. This road will be surfaced with coral rock, no other being available. At Km. 4 the road reaches an elevation of 64 meters and at this point runs within 40 meters of a sheer precipice facing the sea. It is planned to make use at this place of a derrick to deliver rock from the water's edge directly into the tramway cars, whence it can be run by gravity both north and south. It is anticipated that a considerable saving in the unit cost of surfacing materials will thus be effected.

SORSOGON.

The past three months have been unfortunate for this province, in fact except for one week there has been a steady downpour. Five baguios have been felt here, but the last one on the night of December 6 was the only one that did any serious damage and this was due principally to floods, as there was but little wind. All roads suffered heavily both as to surfacing and to bridges. The estimate for repairing the damage done by the typhoon is ₱40,000.

Construction on the Sorsogon-South Road has been practically at a standstill during the last three months. The surfacing now reaches Km. 25.2.

No satisfactory bids were received for the construction of the 210-meter sea wall at Casiguran, and the work will be done by administration.

The Bacon market, 43 by 15 meters, has been completed at a cost of ₱9,266.66.

The provincial building, which is being built by contract by Mr. B. F. Mills, is growing rapidly in spite of delays due to bad weather. Mr. Mills is now up on his second floor and the whole job is 46 per cent completed. The provincial jail and court house is progressing satisfactorily and is now about 30 per cent finished. Messrs. Frank L. Strong & Co., of Manila, are installing all conduits, fixtures, etc., for an electric light and telephone system in both buildings.

The attempt to deepen the first artesian well in Bulan was a failure, and the well has been abandoned.

MASBATE.

An artesian well is now being drilled in San Jacinto, Ticao; depth on December 17, 355 feet.

Approximately 4½ kilometers of the San Fernando-San Jacinto Road have been completed.

The Lumbang-Milagros Road has been extended to Km. 10.5. Light gravel surfacing only has been placed on the last 2 kilometers.

The Colorado-Macatul Point Road was the only road in Masbate that suffered from the baguios. This road was blocked up by slides, but is now passable.

SULU.

Maintenance has been continued along the Maibong and Parang Roads in the usual way. The grass has been cut on 22 kilometers of the Siet Lake Road within the last month. A 10-meter right of way was cleared of heavy cogon grass by 50 laborers in nine days.



Front view of Sulu Public Hospital, opened November 7.

The Sulu Public Hospital was dedicated and formally opened on November 7. The department health officer came with a boatload of friends and officials from Zamboanga to celebrate the occasion. This building has already demonstrated its value in meeting a crying demand in Sulu. From November 7 to December 15 over 80 patients, mostly surgical cases, had been treated in the hospital.

On November 11 the steamer *Mindanao* came from Basilan with 51,000 board feet of lumber for the La Pac school buildings. It loaded 85 tons of hardware, cement and roofing iron at Jolo and proceeded to La Pac. Practically, all the materials for a standard plan No. 6 school building, designed for wood, and a 6-room teachers cottage of similar design were carried in one cargo and delivered on the beach 2 kilometers from the school site.

The construction of the Cagayan dock and causeway has recently been completed at a cost of ₱3,100. This dock is of timber pile construction with approximately 800 square meters deck area, 12 feet of water on two sides at low tide, and is at the end of a 200-meter



Men's ward in Sulu Public Hospital.

coral rock causeway with a 3.5-meter roadway. It is located in what is known as Gunboat Harbor, and is well protected at all seasons of the year.

Another extension of 16 kilometers had been added to the East End telephone line, from Siet Lake to Camp Andres. This is through

an outlaw country, and through the good graces of Maj. Livingston, senior inspector, the commanding officers of the two terminal camps placed all the poles for this line.

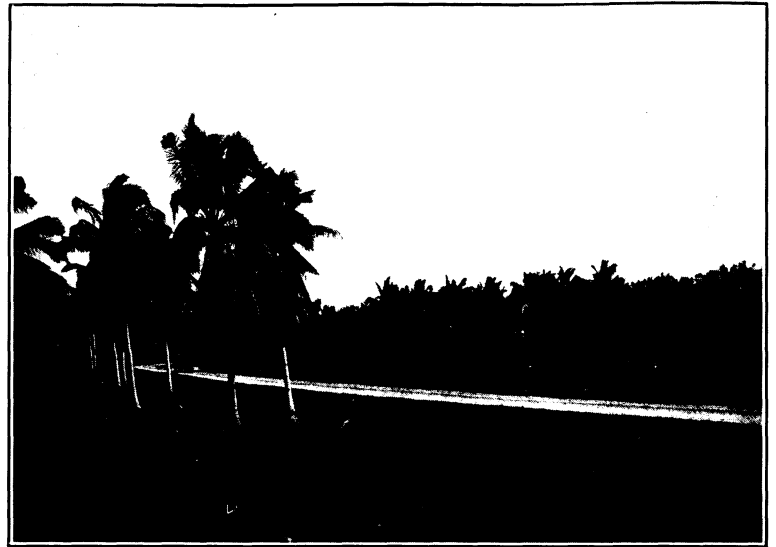
SURIGAO.

By persistent effort of the provincial governor of this province an extension of time for the payment of half of the ₱30,000 loan has been granted; and with this extension the provincial board was able to appropriate ₱5,000 for the continuation of the work on the Placer-Mainit Road which was resumed at the beginning of this quarter. At the same time a special allotment of ₱10,000 for this project was granted upon the recommendation of the senior supervising engineer, Department of Mindanao and Sulu, and through the provincial board, but the work has been abandoned since November owing to the rainy season and scarcity of labor. Laborers on this job, who are mostly from Gigaquit and Cantilan, have gone home to prepare their lands for the planting of rice. However, they are beginning to return, and it is expected that work will soon be resumed in earnest.

Work on the Surigao-Sison Road has also been resumed, but owing to the same reason, it could not be pushed as fast as it was desired. The average number of laborers per month was only 140. However, the subgrading is now near the barrio of Sison, and this has made it possible for some of the provincial employees to take up homesteads in that barrio.

Construction on the Lingig barrio school, Bureau of Education plan No. 2, was started in the latter part of September. Presumably

fifteen minutes, while they have heretofore taken from one to one and a half hours. Gigaquit produces great quantities of copra. Besides this the municipality has built a ₱500 market in the barrio of Bacuag, 10 by 15 meters, galvanized-iron roofed, mancono posts, and gravel floor. It is the intention to put in concrete flooring when there is suf-



Road from Jolo toward Maibong.

ficient funds. This office has also fabricated concrete pipes for sanitary wells and for pipe culverts for that municipality.

Work on the proposed Bilang-bilang wharf in Surigao has been started. The superstructure is a reinforced-concrete slab, somewhat of the design of deck reinforced-concrete girder bridges, supported by reinforced-concrete pile bents. An innovation was introduced in the casting of reinforced-concrete piles, by the use of Trus-Con waterproofing paste by the integral method.

TARLAC.

Work on the Tarlac-La Paz Road has been progressing satisfactorily, about 7 kilometers having been completed during 1915. This number could have been increased to 11 or 12 had a road roller been available.

Next year the following roads will be under construction: Camiling-Pangasinan Boundary Road; Tarlac-La Paz Road; Gerona-Pura-Nueva Ecija Road.



Carrying hemp to Jolo on pack animals.



New Jolo entrance to Jolo-Maibong Road.

it is now finished. It was convenanted in the contract to have the building complete by the end of November. Nothing could be ascertained, however, as no communication exists between Surigao and that barrio until after March.

Actual work on the Cabuntog barrio school, plan No. 2, will be started as soon as the people have the lumber sawn which they had promised to furnish. This building could have been built a long time ago, for the work was started in 1911 and footings have been placed. Only recently the people have come to the office stating that they now realize their fault in failing to fulfill the obligation they had promised and asking that the work be reopened. They were to furnish all lumber materials and labor.

There are four schools pending in this province; one No. 7 in Tandag; one No. 4 in Placer; one No. 2 in Hinatuan; and one No. 2 in Surigao.

Quite recently some of the municipalities have shown great interest in public works. Dapa is trying hard to finish their municipal building this year. It was started nine years ago and has cost the municipality in the neighborhood of ₱9,000. Hinatuan appropriated ₱2,000 in September for the construction of an earth road from the town to the barrio of Malixe, a great hemp-producing barrio. The location runs on a level plain and is on the projected alignment of Surigao-Hinatuan Road. It is 7.5 kilometers in length. Gigaquit, under the personal leadership of Mr. Recaredo Gonzales, the municipal presidente, has recently built by voluntary labor an earth road 1.5 kilometers long from town to the beach parallel to the Gigaquit River. The road runs through nipa swamp and mangrove. By opening this road, the rowboats from the steamers now take only

Gravel for the Pura-Nueva Ecija Boundary road is being furnished by a Mr. José Ramos, local contractor, at ₱2.80 per cubic meter unloaded at the Gerona railroad station.

The following are average costs for gravel delivered by administration between Kms. 12 and 22 on Tarlac-La Paz Road:

Screening and delivering by banca to tramway.....	₱1.60
Hauling by tramway, average haul 19 kilometers.....	1.92
Rent of tramway, supervision, etc.....	.78
Total cost per cubic meter.....	4.30

The fabricated steel for the Camiling Bridge has been advertised and the contract let to the Atlantic Gulf and Pacific Co. for ₱21,175. The substructure will soon be advertised and construction will likely be started not later than February 1, 1916.

A relocation of the Capas-Bamban Road is contemplated, to pass through Concepcion. This contemplated change will in no way affect the distance between Tarlac and Pampanga and it will be of great benefit to the owners of the extensive rice and sugar lands between Concepcion and Bamban. The old road between Capas and Bamban goes through a mountainous, sandy country and therefore its abandonment will not cause any hardship.

Relocation of the Paniqui-Anao Road will also be undertaken very shortly. The present road is very low and it is safe to say that the water stands on about half of it to depths varying from 50 centimeters to one meter; besides, a bridge not less than 30 meters long will be required. This road is approximately 8.1 kilometers long. The new road location will start from the Paniqui-Moncada Road at Km. 28 just after crossing the San Isidro Bridge, and from this point to Anao will be on high ground with no bridge required. Besides it is only about 4 kilometers long.

The Camiling presidencia is now completed at a total cost of ₱28,566.59. It is a concrete building of the Urdaneta type, two stories high, with steel trusses and tile roof. It is 11.7 by 17.7 meters in horizontal dimensions. The building has been accepted by the municipal authorities.

Although this province has been badly infested with locusts, the rice crop has not suffered, but the baguio of December 6 and 7 did considerable damage which has not been fully ascertained.

On account of the harvest, laborers are beginning to be scarce.

TAYABAS.

Construction of Tayabas-Lucban Road has been suspended pending additional appropriations. The complete portion has been recommended for declaration as first-class and it is expected that the remaining 3½ kilometers will be completed during the coming dry season. Bull-carts with a half-ton load can now negotiate the worst grades with only one animal.

The construction of the Tigaon Infanta school buildings has been much delayed by the scarcity of reinforcing steel in the Manila market.

A ticket-booth has been completed for the Tayabas public market and materials are en route for a portion of the tables. The municipal council intends to complete all the tables during 1916.

The typhoon of December 6 was especially destructive in this district. While the previous storms had left the roads and bridges in very fair condition, this one destroyed bridges, culverts and road bed over the entire province. The damage to roads and bridges in Tayabas and Marinduque is estimated at ₱100,000. The water rose in practically all the rivers far above all previously existing high-water marks, and the drift was correspondingly heavy. At least one bridge was literally knocked to pieces by the 4-ton boulders which the floods hurled against it.

The construction of the Panaon-Unisan Road has progressed very slowly, due to very inclement weather and the difficulty in obtaining surfacing material.

The province will discontinue the operation of a corral at the end of 1915 and will dispose of the stock and equipment at auction. The White truck recently purchased will handle all Government hauling on the improved road system.

MARINDUQUE.

Mr. Delmar-Smith Clinton has been awarded the contract for the construction of the Boac-Gasan bridge No. 16.1, at ₱15,040.00, the province to furnish the steel and waterproofing materials. Casting of piles is under way and the work should progress rapidly.

Acceptance of the Boac woodworking shop has been requested. This was a small building of a temporary character.

The towns of Mogpog and Santa Cruz suffered severely from the effects of the earlier baguios. His Excellency, the Governor-General, has approved as a relief measure the release of ₱10,000 for the construction of a road from Mogpog to Balanacan port and ₱10,000 for the road from Santa Cruz to Torrijos.

Three kilometers of very good cart road were constructed on the Buenavista-Torrijos Trail at an average cost of ₱800 per kilometer through mountainous country.

River control and irrigation investigations have been requested by the municipality of Boac.

ZAMBALES.

Two culverts, one 3.5 by 2 meters and another 3.5 by 2.5 meters have been finished during the quarter. This marks the completion of the culvert construction between Santa Cruz and Candelaria.

The plans for the Yamot culvert, a 3.6-meter span on pile foundation, have been received and all piles have been cast. It is hoped to finish the bridge by administration early next year.

Money has already been made available for the construction of the Lucapon Bridge between Candelaria and Santa Cruz and construction will be started as soon as the plans are drawn in the Manila office.

After a delay of about a month from lack of funds, additional money has been appropriated for the completion of the Subic water supply system. The estimated cost was exceeded due to the increased price of materials since the war, and to the fact that rock was encountered in the tank excavation and had to be blasted.

Money was made available for the new trail from Amungan to San Lorenzo and construction was started in November. The trail is 2 meters wide. Up to date the section from Bolauin, Km. 12, to Salasa, Km. 16, has been cleared and graded so that it is now passable on horse-back. As soon as all crops between Amungan and Bolauin are harvested construction will be started from Amungan northward. So far, no trouble has been encountered in securing a free right of way.

Two shallow tubular wells have been driven by administration for the municipality of Palauig. Standard suction pumps are used. The wells give good results and the Palauig people are satisfied. It is expected that other municipalities will follow the example of Palauig.

During the quarter, two rooms in the provincial building were fitted and repaired for the offices of the district auditor and the provincial assessor.

Two and six-tenths kilometers of the Iba-South Road, Iba-Botolan section, have been recommended for designation as first-class road. This makes a total of 4.5 kilometers of first-class road in the province.

A temporary floating bridge has been constructed over the Bancal River. The bridge is 3 meters wide and 160 meters long, made entirely of bamboo and held in place by means of wooden posts. Circular bejuco rings hold the bridge to the posts, thus permitting the bridge to rise or go down with the tide.

ZAMBOANGA.

The recently authorized repairs on the Little Santa Cruz lighthouse were completed December 15. The work consisted of renewing the sway bracing and platform on the lighthouse tower and making a few minor repairs to the keeper's cottage.

During the last six months standard earth depositories have been constructed on all the second-class roads in the province and portions of these roads resurfaced and widened. A recommendation has been forwarded to the provincial board designating 36.2 kilometers as first-class, the first road declaration to be made in the province. The remainder of the second-class road will be declared as soon as it can be brought up to the proper standard.

A reinforced-concrete toilet and bathhouse is under construction on the provincial high school grounds. The building will have bath and locker rooms and will be equipped with modern plumbing throughout. Water is to be supplied temporarily from the Zamboanga ice plant until the completion of the Zamboanga waterworks system.

Bids will be opened on January 10 for the construction of 60 linear meters of reinforced-concrete pile wharf at Zamboanga. The plans call for reinforced-concrete piles 50 by 50 centimeters in section and from 15 to 17 meters in length. The only timbers to be used on the wharf are the fender piles along the front face. The tops of these piles are supported by nests of three springs, each capable of resisting not less than 5,000 kilograms when compressed 15 centimeters.

The contract for furnishing coral surfacing on the Zamboanga-East Coast Road from Km. 18.5 to Km. 21.5 has been awarded to Z. H. Shinn for ₱1.55 per cubic meter. As no gravel is obtainable for this section, coral rock is brought up the rivers as far as possible in vintas and then hauled an average distance of two kilometers to the road. Finger coral is used as a binder. The continued rains have greatly retarded the grading work on this road.

The concrete arches at the entrances to Plaza Pershing and the concrete roof of the band-stand in the plaza were completed during December. The band-stand roof is slightly domed and supported by seven reinforced-concrete pillars on ornamental pedestals. The roof is surrounded by a low balustrade on which are seven concrete flower urns and will be covered by a foot of soil in which flowering plants and shrubs are to be planted. The structure has been electrically wired, all wiring being placed in concealed conduits with condulets, and connected by underground circuit with the local cinematograph and lighting company's system.



Band stand, Zamboanga.

Work on the Zamboanga waterwork tunnels is progressing very satisfactorily. These tunnels were started with a 4 by 4 foot section but it has since developed that better progress can be made by increasing the height to 5 feet. Because of the small size of the headings, three eight-hour shifts of two men each are employed. An inclined shaft 130 feet long, on a 17-degree slope is now being sunk, from the head of a gulley to the middle point of the longest tunnel. This should reach the tunnel line during the latter part of January after which work will be carried on at four headings. The remaining excavation and trimming required on the distributing reservoir has been practically completed and it is hoped to begin placing the concrete lining about February 1st. The first small shipment of pipe for the system was received December 16th and according to recent cable advices another shipment was made from New York on November 12.

GENERAL ITEMS.

STRUCTURAL TIMBERS IN THE PHILIPPINES.

Although there are many hundreds of varieties of timber in the Philippine Islands the supply of native lumber available in Manila and in the other larger business centers of the Philippine Islands is usually cut from the following woods:

(1) Finish timbers.	(2) Common building timbers.	(3) Building timbers (often but not always available).
Narra. Ipil. Acle. Tindalo.	Molave. Yacal. Guijo. Apitong. Red lauan. Almon. White lauan.	Mangachapuy. Montol. Supa. Dungon. Lumbayao. Amuguis. Nato. Balete. Macaasin. Malugay. Tabigi. Calantas. Palosapis.

Almost any of the larger lumber yards can furnish all of the timbers mentioned in groups 1 and 2, but the timbers mentioned in group 3 are by no means as commonly obtainable. This is not surprising when one remembers that probably 75 per cent of all of the standing timber in the Philippine Islands belongs to the Diptocarp family, the commoner commercial lumbers produced by the various species of this family being yacal, guijo, apitong, tanguile, red lauan, almon and white lauan. In the past it has been customary in writing Government specifications to call as freely for the lumbers mentioned in group three as for those mentioned in group two with the result that some of the lumbers in group three are now sold at prices which are approximately as high as the price asked for the hardwood finishing lumbers mentioned in group one though their intrinsic value does not at all warrant such a price. As there is probably more yacal in the forests of the Philippine Islands than there is of all of the other hardwoods combined, and as there is more guijo and apitong standing than there is of all of the timbers mentioned in group three a readjustment of the standard specifications naturally suggested itself and in the investigation which was undertaken in order to determine this question the following points of interest were brought out.

Of the lumbers above mentioned, molave, narra, ipil, acle, tindalo and yacal are the only ones which may be said to be even approximately free from the attacks of the white ants. Even these woods are not always overlooked by this pest, and when wet or green are, in fact, more or less freely attacked, but as timbers for use in building construction they may be considered as practically free from the attack of the white ants for these insects will not, under ordinary circumstances, invade any of these timbers after they are seasoned. None of the other woods on this list are even moderately secure against early destruction by the white ants, and wherever they are used it must be recognized that they are liable to attack at any time.

In building construction the matter of next importance is the liability to attack by the small borer commonly known as the bokbok. This borer enters many kinds of timber very freely and by boring about in the wood produces the wood dust which is so much of a nuisance in many buildings constructed of soft woods. The bokbok is almost as destructive of soft wood as are the white ants and is even harder to get rid of, once it obtains a hole in any timber. Its progress is slower than that of the termites, but usually the ultimate effect of its presence is just as serious. Yacal, molave, narra, ipil, apitong (heart wood) and true tanguile (heart wood) may be said to be practically free from attack by these borers. Commercial tanguile, red lauan, almon and white lauan are freely attacked. Some claim that a coat of paint will keep the borers from entering these woods, but this is not yet well substantiated.

In exposed positions both ordinary decay and dry rot take place least rapidly in molave and most rapidly in the lauans. However, the tendency of a lumber to decay when exposed to the free action of the elements is not a proper criterion of its usefulness for interior work for where kept dry, as in an ordinary building, and covered with oil or paint any of the above-mentioned woods soon become so dry that they are not attacked by the ordinary decay nor by what is known as dry rot. This is particularly true of truss timbers which, at least when placed under a galvanized-iron roof, are sub-

jected to temperatures which make the growth of any form of vegetable life entirely impossible. Rots of all kinds are vegetable forms which depend for their growth on a reasonable supply of moisture and on normal temperatures. For inside finish, therefore, it may be said that any of these timbers will have a satisfactory life, when not attacked by termites and borers, for under all normal conditions they will soon become so dry that the bacteria which cause rot cannot possibly grow in them, and where used for roof timbers they will have the added protection of high temperature.

All of these woods shrink considerably while seasoning and should, therefore, be thoroughly seasoned before they are used. The hard woods probably shrink less than any of the soft woods, but as between guijo, apitong, lumbayao and the lauans there is very little difference. All of the ordinary building lumbers may be expected to shrink at least a quarter of an inch to the foot of width after they have seasoned in an ordinary lumber yard six months. To reduce the bad effects of this shrinking kiln dried lumber should be used for floors and for all finishing work. Where kiln dried lumber cannot be had the individual boards should be made as narrow as possible so that the shrinkage cracks may also be narrow, or if possible local stock should be carried and care should be exercised to so stack the lumber as to guarantee thorough air seasoning.

All of these woods warp freely when exposed to unequal drying. In this respect molave and ipil are probably the best. Guijo is probably the worst. There is not, however, enough difference to mark any of these timbers as conspicuously satisfactory. Where used in six or eight inch widths, finishing lumber should be center grooved which so weakens the center of the board that warping is confined to the flat areas on the sides of the groove. For form work four and six inch widths should be specified. The warping of good lauan, when used in form construction, is little if any greater than the warping of the Oregon pine so often used for this class of work. Four and six inch boards, can be bought cheaper than twelve inch boards. It would seem, therefore, that it is doubly advisable to order narrow boards when requisitioning native lumber, either for interior finishing or form work.

Where the use to which any lumber is to be put makes the beauty of the wood an important consideration it is more a question of the manner in which the lumber is sawed than it is of the kind of wood that is selected. Thus, yacal and apitong have a rather poor grain and are consequently not supposed to have the beauty which is possessed by well sawed tanguile or lumbayao, but as it is easily possible to saw either yacal or apitong so that it possesses a finer appearance than is shown by lumbayao as ordinarily sawed, it can be readily seen that the kind of wood used is not a matter of so much importance as is its proper selection. Moreover, most of the structures in which these woods are used for finishing purposes are painted rather than varnished and where this is done the matter of the appearance of the wood itself is of no importance.

All sap wood must be removed from these timbers. Sap wood is easily detected except in white lauan and in almon where it is often overlooked on account of the slight difference in color between the sap wood and heart wood.

In view of these facts it seemed advisable to define three classes of building construction.

(1) Permanent buildings, that is buildings which are expected to last in excess of 25 years. This class of buildings will include all provincial government buildings, standard presidencias and special school house designs.

(2) Semi-permanent buildings, that is buildings which have an assumed life of from 10 to 25 years. Standard markets and standard school houses belong to this class.

(4) Temporary structures, that is structures having an assumed life of less than 10 years.

Buildings of the first type will be of stone or concrete, and will, so far as possible, have concrete floors, partitions and ceilings and tile roofs. Wherever any wood work is used in these buildings either for windows, doors, frames, trusses or interior trim hard wood lumbers should be specified. By following this course it is hoped that a relatively permanent structure can be obtained and that the ravages of the borers and the white ants can be reduced to a minimum.

Buildings of the semi-permanent type will be distinguished from those of the permanent type principally by the fact that on this type of structures corrugated galvanized iron roofs will be used and by the fact that hard woods will be specified only for doors and windows, and for timbers in contact with concrete. On account of the high temperature prevailing under a galvanized iron roof, apitong may be expected to last fully as long as the guijo which has been called for in the past, and in view of the fact that it is much cheaper, should be used for all truss timbers. Apitong floor joist, studding, rafters, flooring and finishing lumber should also be specified, with the exception that in Gabaldon school buildings, where the floor joists usually come within about three feet of the ground yacal should be specified. However, while apitong should be specified for practically all of the wood work in buildings of this class, the free substitution of other lumbers of the same or slightly better grade should be provided for and it will then frequently be possible to improve the appearance of the interiors of buildings of this class, especially where a varnish finish is used, by selecting wood that has a more pleasing appearance than has ordinary untreated apitong.

For buildings of a temporary nature and for form lumber the lauans may be considered standard, but where prices make such a substitution advisable, apitong or lumbayao can be freely used as substitutes. The lauans are commonly sold as tanguile, which is the best grade of red lauan, red lauan, almon, and white lauan which is usually mixed an unimportant percentage of other woods of about the same grade. Where the lauans are used for exterior finish on buildings which are expected to last for five years or more they should grade true and sap wood should be rigidly excluded, for form lumber and for other forms of strictly temporary construction the inclusion of even a considerable percentage of timber which is not lauan should not be considered cause for rejection, and a moderate amount of sap wood is no disadvantage.

For wood in contact with concrete, ipil or molave should be uniformly specified. Ipil, narra or yacal should be specified for windows, doors, window frames and door frames of both permanent and semi-permanent buildings.

In view of the facts which have been mentioned herein, and in order to simplify the question of substitutions, it has seemed advisable to select the three most prominent woods in the Diptocarp family, Yacal, Apitong, and Lauan, both because these woods are common, and because they fairly represent the type of lumber desired for permanent, semi-permanent and temporary construction. Where these terms appear in Bureau of Public Works specifications in the future they are not, therefore, to be interpreted in the narrow sense as the names of lumbers, but in the broader sense as generic terms intended to symbolize the three grades of lumber—hard and durable, medium, and soft lumbers—and it is expected that though the woods sold under these names will be freely used, engineers will not hesitate to make such substitutions as are regularly provided for whenever it is advantageous to do so. It is hoped that this new system will aid the lumberman by allowing a little less strict classification of his lumbers and that it will assist both the lumberman and the public by preventing the wide fluctuations in price that have been noted in the past in many middle grade lumbers.

DESTRUCTIVE TYPHOONS IN SOUTHERN LUZON, 1915.

The months of October, November and December of this year were marked by an unprecedented series of typhoons passing over central and southern Luzon. Three of them deserve special mention. The first of these occurred on October 23, the provinces of Albay and Ambos Camarines suffering the greatest damage. On November 3, a second typhoon passed somewhat to the north of the earlier one. The effects were less severe, and were largely confined to the provinces to the north of Manila—Nueva Ecija, the Mountain Province and La Union. On December 6 a third typhoon passed between the paths of the two earlier ones. The wind was less severe, but the accompanying rains were heavier, especially in the provinces of Laguna and Tayabas.

TYPHOON OF OCTOBER 23, 1915.

The area affected by high winds on October 23, is shown by the accompanying map. The Weather Bureau has furnished the following meteorological data:

Stations.	Barometric pressure.		Wind.		Maximum rainfall in 24 hours beginning 6 a. m.	
	Height.	Date.	Veering or backing of direction.	Maximum force. ^a	Amount.	Date.
Legaspi, Albay	736.70	Oct. 23, 8.20 a. m.	NW-W-SW-S	10	120.4	Oct. 22
Naga, Ambos Camarines.	723	Oct. 23, noon	NW-N-E-SE	12	85	Oct. 23
Atimonan, Tayabas	742.81	Oct. 23, 8 p. m.	NW-E-NE-E	12	114	Oct. 23
Batangas, Batangas.	732.70	Oct. 24, 1.45 a. m.	NW-N-NE-E	11	167.9	Oct. 23

^a Force 10 corresponds to velocity, 88 to 100 kilometers per hour; 11 to 118-120; and 12 to 120 and over.

^b The greatest rainfall took place probably on the 23d, but no observations were taken in the afternoon of this day as the rain gauge was blown by hurricane winds.

In addition, the Lieutenant governor of Catanduanes reported a minimum barometric pressure of 715 millimeters in Virac at 6.18 a. m., October 23.

The center of the typhoon appears to have passed very close to



Bridge 53.9, Manila-South Road, San Cristobal River, destroyed December 6, 1915. View looking downstream. Note drift of bamboo roots and present width of stream.



the towns of Virac (Catanduanes), Tabaco (Albay), Naga (Ambos Camarines), and thence over southern Tayabas, northern Marinduque and Mindoro. The vagaries of this path show the influence of topography, especially of the higher mountains. The average velocity of the storm center is estimated at about 18 kilometers per hour, the maximum wind velocity being somewhat in excess of 120 kilometers per hour. Accompanying the typhoon was a rainfall estimated at about 25 millimeters per hour for five to seven hours.

The extensive damage to buildings is largely explained by the character of construction. The photograph of Polangi, Albay, shows the typical provincial construction, bamboo-and-nipa "shacks" predominating, with a considerable number of more permanent buildings in the central town, or "poblacion" of each municipality. Bamboo houses were flattened out, while the stronger wooden frame houses were often damaged due to their lack of bracing. Galvanized iron roofs are in general poorly put on, as evidenced by the extensive unroofing.

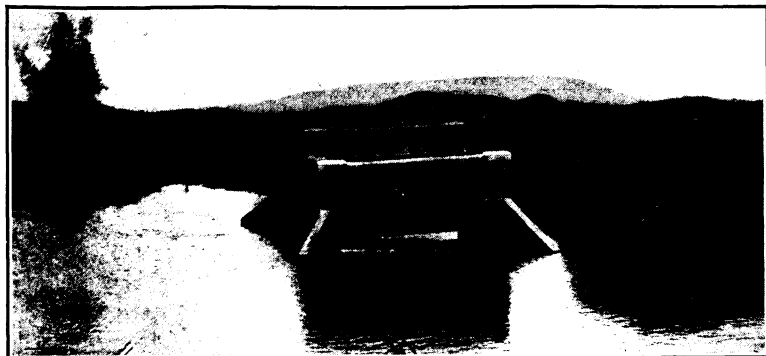
It is worthy of remark that the permanent buildings erected by

the Bureau of Public Works were almost undamaged. Standard market buildings, although several were directly in the path of the storm came through without the loss of a single sheet of roofing iron. The tienda buildings were undamaged, except for one building where a part of the media-agua was crumpled up. The school buildings did not fare so well, but even here, the damage was small, a few sheets of roofing iron being wrenched off here and there. The Tabaco (Albay) Intermediate school was damaged more severely than any other of the concrete (Gabaldon) school buildings. The Naga (Ambos Camarines) Provincial Government Building damaged, as shown herewith, was roofed after the earlier and less satisfactory method.

The force of the wind is well attested by its blowing the contractor's pile driver into the river at the Quinala bridge (under construction). This outfit weighed something more than 10 tons, and the top of the derrick was securely guyed. The driver was not overturned but slid, through the force of the wind, off the falsework into the river.

The following estimate of damage to public buildings has been compiled:

School buildings:	
Permanent.....	P19,500
Semi-permanent and temporary.....	45,000
Market and tienda buildings.....	100
Provincial government building, Naga.....	4,000
Total damage to government buildings, say.....	83,500
Municipal government buildings, probably not over.....	15,000



Culvert No. 42.13, Albay-Camarines Inter-Provincial Road (north of Polangi, Albay). 4-meter span, undermined and road washed out for about 30 meters by flood of October 23, 1915. This culvert appears to be intact, structurally.

This typhoon demonstrated the necessity for proper methods of building construction. The standard concrete market and tienda buildings were practically unharmed. Corrugated iron roofs, where put on according to late Bureau of Public Works specification, stuck, while most of the rest did not.

The road around Mt. Mayon sustained severe damage, from immense quantities of mud and boulders, brought down from the slopes of the mountain. The culvert in Kilometer 7, Legaspi-Libog Road, a view of which is shown, is a typical failure. The size of the present opening attests the amount of water which came down.

Near the town of Camalig, south-west of Mt. Mayon, such a slide covered about 200 meters of highway to an average depth of 1.50 meters. The Legaspi-Libog section was practically obliterated for about 3 kilometers, and the Tabaco-Ligao section severely damaged.

From Kilometer 42 to Kilometer 48, on the Albay-Camarines Inter-provincial road (north of Polangi) practically the entire road was topped by the flood. This section runs through the middle of a fairly wide valley, and parallels the main drainage stream. The water passed over the embankment, occasioning the loss of most



Street in "poblacion" of Polangi, Albay. This got the full force of the wind during typhoon of October 23, 1915. This shows the type of "strong material" construction, and the effect of high winds upon it.

of the road metalling. Culvert No. 42.13, shown herewith, was the only bridge casualty in this section. Just south, a small stone culvert, dating from the Spanish régime was undermined and lost.

At the provincial boundary, the road crossed the Argos River on a concrete pile trestle of nine 7.50 meters spans. The spans were skewed 30°, making the clear opening of each span, at right



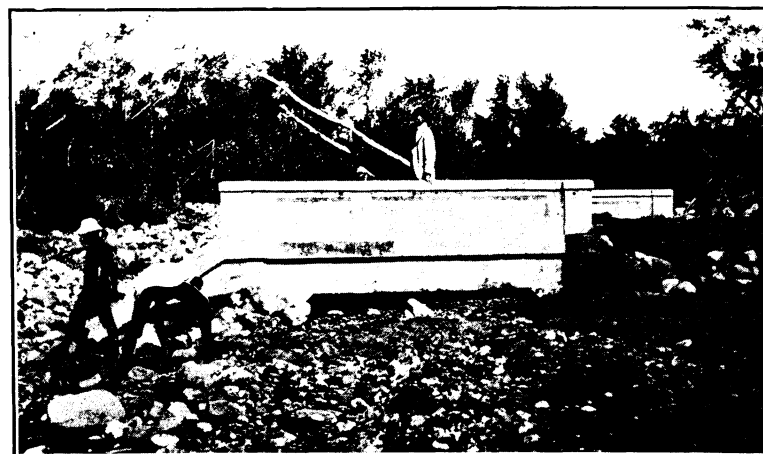
Culvert in kilometer 7, Legaspi-Libog Road. Culvert appears structurally intact. Note width of present opening and character of debris—boulders, mud, and vegetation.

angles to the current, but 5.90 meters. The railway line between Iriga (Ambos Camarines) and Legaspi, crossed about 30 meters upstream, their bridge having two 100-foot steel spans, not skewed. The general layout is shown by the sketch map. While no conclusive first hand evidence is obtainable, the writer believes that his



Provincial building, Naga, Ambos Camarines, unroofed and part of east side blown in during typhoon of October 23, 1915.

reconstruction of events is the most probable of the various ones advanced. It appears that the water rose above the soffit of the highway bridge, and that drift dams formed both at this and at the railway bridge. The pier of the railway bridge partially failed, probably on account of faulty concrete (the lower portion of this



Bridge No. 15.72, Sariaya-Candelaria Road, October 25, 1915.

having been put in under water), this being aided by the eddy which must have formed down stream and to the right. The pier tilted to the right, unseating the end of the Camarines span. This span, caught by the current, swung through about 45°, pulled loose from the abutment and was rolled over in front of the end span



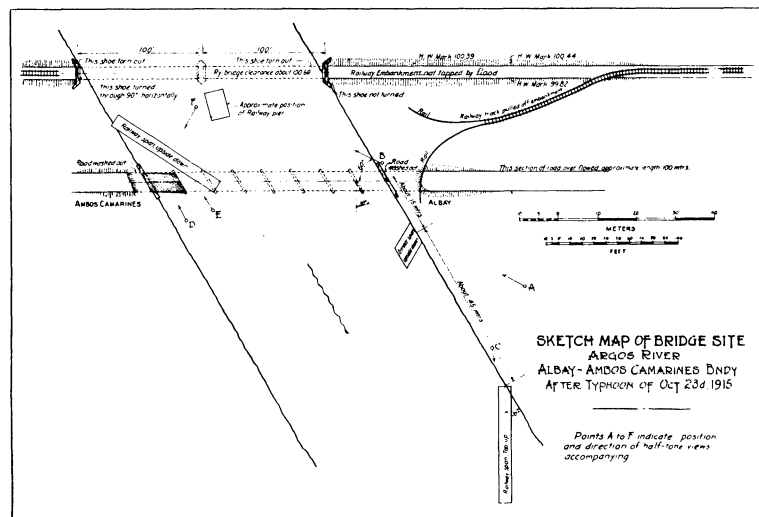
Shore span of highway bridge, and first railway span, Camarines bank, Argos River. Bottom lateral system of steel span shows.

(on the left) of the highway bridge. Thus protected, the end span did not fail, but the constricted waterway resulted in the remaining bents, already underscoured to some extent, underscoursing so much that their lateral support was insufficient, and these eight spans collapsed. The drift dam then went out, and the current completed the collapse of the railway pier. The steel span on the right, supported by the drift which had accumulated under it, was floated some 300 feet down stream on the crest of this local flood, dragging with it for a considerable distance, the railway track. The present track position, indicating as it does, that the span on the left dropped, while that on the right was moved horizontally, but did not drop enough to allow the track to pull over the top chord, corroborates these assumptions, as does also the position of the railway pier.

With the exception of the Argos Bridge, owned jointly with Albay, the Province of Ambos Camarines sustained practically no damage to roads and bridges. For the two provinces, the total loss based upon latest valuation was approximately ₱85,000.

TYPHOON OF NOVEMBER 3, 1915.

The center passed considerably to the north, bringing rather high winds and heavy rains through parts of Nueva Ecija, the Mountain Province and La Union. The damage to public works was very



light, and was confined mostly to temporary bridges, and unsurfaced roads.

TYPHOON OF DECEMBER 6, 1915.

This typhoon swept the central portion of Tayabas, and the southern shore of Laguna de Bay, passing thence over Cavite to the China Sea. The wind velocity was unusually low, as a result of

which damage to houses and crops was very slight. While no accurate figures are at hand, information from Albay Province (considerably to the south of the storm center) states that floods were higher than on October 23. Practically all of the repairs accomplished in Albay since the first typhoon are reported lost. Permanent bridges and culverts were damaged to the extent of ₱5,000, while damage to temporary bridges amounted to ₱3,700.

The Provinces of Tayabas and Laguna reported losses to bridges as follows:

Name.	Location.	Description.	Extent of damage.
TAYABAS.			
1. Damakaa River	0.4 Lucena-Atimonan Road.	100 ft. steel span 6 mtr. approaches.	Abutment settled. Steel usable.
2. Pagsabayan River	15.7 Lucena-Atimonan Road.	2-80' steel spans	Pier undermined steel usable.
3. Sariaya River	13.2 Lucena-North Boundary Road.	2-9.0 mtr. I-beam spans, R. C. Floor.	Destroyed. Part of I-beams usable.
4. Maramo River (Candelaria).	23.6 Lucena-North Boundary Road.	56 ft. steel truss span.	Superstructure carried away.
5. Lagnas River	32.0 Lucena-North Boundary Road.	3-12.0m R. C. girders.	Destroyed.
LAGUNA.			
6.	87.0 Manila-South Road.	Spanish culvert	Washed out.
7.	69.8 Manila-South Road.	Old Spanish arch	Part of arch ring, and one wing wall fallen.
8.	0.5 Kilometers east of Nagcarlan.	2 span steel truss, Spanish construction.	Destroyed.
9. San Cristobal River	53.9 Manila-South Road.	22.0 mtr. concrete arch.	Destroyed.

All these failures were due primarily to lack of waterway. The bridge near Nagcarlan (Laguna), according to the best available information had been in about thirty years. A casual inspection of the site seemed to indicate that its waterway was fully 25 per cent in excess of that required. The span at San Cristobal River was practically the full width of the stream.

The Manila-South Road was damaged from Biñan south into Tayabas. The road was topped in many places by the floods, losing much of the surfacing, and in a few places, the subgrade.

A CALL TO ACTION—STEEL BOOM MENACES COST AND EVEN ACTUAL EXECUTION OF ENGINEERING WORK.

(Reprinted from the Engineering Record, No. 27, 1915.)

Civil engineers and contractors throughout the country have been watching the phenomenal advance in steel-mill activity without realizing that they are soon to be actors in the great drama and not merely spectators. The steel industry will in 1916 play a most important part in the cost and execution of all engineering work. Already prices have increased greatly. The trend is still sharply upward and the rounding of the curve is nowhere in sight. On the contrary, the awakening of the country's domestic business, coming at the same time as the large, and always increasing, volume of war orders, may send the market considerably higher. If the war should end quickly, the situation would change at once, but the safer course is to assume that hostilities are to continue.

Nor is the cost of next year's work alone at stake. The steel industry may determine whether work is to be done at all. The reason is on the surface. Already many mills are sold up to capacity for three or four months, while not a few are committed for their entire output until the second half of next year. That presages shortage not only of the actual steel materials entering into construction—such as shapes and reinforcing bars—but of plates, angles, rounds and other products essential to the manufacture of contractors' equipment. Already one manufacturer reports that the best delivery he can get on rounds for car axles is three months, while fifteen to twenty weeks is the quoted delivery on other finished steel products. Fortunately, equipment and machinery manufacturers are fairly well stocked, but the fabricated and partly fabricated equipment in hand was probably never lower. The first spring rush will consume the supplies now awaiting fabrication, and then will come delays that may be serious enough to cause the postponement of many an important and pressing job.

In the structural field, reports from Pittsburg show that the fabricating shops, too, have felt the pressure, due, of course, largely to the domestic revival. Practically all of them are filled up for the next four to six months, except as to heavy shapes. Shortage of billets may interfere with orders for even heavy sections, though the shops may be in need of work. Some relief is possible from increases in capacity, but this is not expected to make any material difference.

It is the engineer's turn to think fast. The first man to let contracts for next year's work will be the most certain to have them executed and will get the lowest prices. In November many bond issues were voted. There should not be an instant's delay in starting the machinery moving toward the closing of the contracts.

The contractor no less than the engineer needs to understand the gravity of the situation. He would best be in close touch with the equipment manufacturers. He is not likely to commit himself for new plant until contracts are in hand, but when time for action comes he must know where he can get what he needs, and how soon.

The manufacturers are fully awake to the conditions. They are doing all they can to secure adequate stocks of steel, but belated orders for equipment are almost certain to be accepted only on long delivery terms or to be refused. Then, too, the prices on them will necessarily be higher than for early purchases, though higher price levels must be expected even for the first deliveries.

This is not a time for speculation or procrastination. Where work is authorized, engineers owe it to their clients, municipalities, companies, to let the work just as soon as possible. Where work is imperative, but plans are not yet made or authority secured, the necessary machinery must be started at once. The penalty for delay promises to be severe.

FINANCIAL.

APPROPRIATIONS AND ALLOTMENTS, FISCAL YEAR 1915.

No allotments have been made since our report of October 1, 1915.

LOANS FOR ROADS, BRIDGES, SCHOOLS, MARKETS, WATERWORKS, ETC., FROM OCTOBER 1, 1915 TO DECEMBER 31, 1915.

Provinces and projects.	Act Nos.		Total.
	1729.	1749.	
Bohol: For the purpose of installing a waterworks system, at Loay.....		P6, 150	P6, 150
Pangasinan: For the purpose of constructing a central school building, at Villasis.....	P2, 000		2, 000
Total.....	2, 000	6, 150	8, 150

FIRST-CLASS ROADS IN THE PHILIPPINES, DECEMBER 31, 1915.

	Kilometers.
Albay.....	134.8
Ambos Camarines.....	121.1
Antique.....	56.1
Bataan.....	21.7
Batangas.....	111.4
Bohol.....	68.5
Bulacan.....	91.1
Cagayan.....	32.0
Capiz.....	135.0
Cavite.....	68.2
Cebu.....	200.0
Ilocos Norte.....	59.5
Ilocos Sur.....	150.4
Iloilo.....	162.3
Isabela.....	49.8
Laguna.....	125.4

First class roads in the Philippines—Continued.

	Kilometers.
La Union.....	66.9
Leyte.....	117.8
Misamis.....	58.2
Nueva Ecija.....	80.5
Occidental Negros.....	142.1
Oriental Negros.....	55.8
Pampanga.....	87.2
Pangasinan.....	232.3
Rizal.....	122.5
Samar.....	73.3
Sorsogon.....	82.4
Surigao.....	15.7
Tarlac.....	43.4
Tayabas.....	137.3
Zambales.....	4.5
Agusan.....	7.6
Baguio.....	24.0
Benguet Subprovince.....	63.3
Cotabato.....	5.2
Davao.....	2.8
Lanao.....	1.7
Sulu.....	12.4
Zamboanga.....	36.2
Mindoro.....	3.6
Total.....	3,064.0

SELECTED.

"IF I KNEW YOU AND YOU KNEW ME."

If I knew you and you knew me,
'Tis seldom we would disagree;
But, never having yet clasped hands,
Both often fail to understand
That each intends to do what's right,
And treat each other "honor bright."
How little to complain there'd be.
If I knew you and you knew me.

Whene'er we ship you by mistake,
Or in your bill some error make,
From irritation you'd be free
If I knew you and you knew me.
Or when the checks don't come on time,
And customers send us nary a line,
We'd wait without anxiety,
If I knew you and you knew me.
Or when some goods you "fire back,"
Or make a "kick" on this or that,
We'd take it in good part, you see,
If I knew you and you knew me.
With customers many thousand strong
Occasionally things go wrong—
Sometimes our fault, and sometimes theirs—
Kind friends, how pleasant things would be
If I knew you and you knew me.

Then let no doubting thoughts abide
Of firm good faith on either side;
Confidence to each other give,
Living ourselves, let others live;
But any time you come this way,
That you will call, we hope and pray;
Then face to face each shall see
And I'll know you and you'll know me.

—Selected.

APPENDIX A.

CIRCULAR LETTERS ISSUED BY THE CONSTRUCTING DIVISION FROM OCTOBER 1, 1915, TO DECEMBER 31, 1915.

MANILA, October 5, 1915.

Constructing Division Circular No. 160.

SIR: With reference to Constructing Division Circular No. 156, relative to concrete testing, I have the honor to inform you that the following quotation on galvanized cast iron gang molds (for three 8 by 16 inch cylinders) as shown by plan attached to Circular No. 156, has been received: In lots of 50, ₱42.00 each; in lots of 100, ₱40.95.

An alternative type of form, made from 8-inch well casing, has been devised. (Blueprint photograph enclosed). This is not a gang mold, and one form is necessary for each sample, three forms thus constituting a set. These can be manufactured by the Bureau of Public Works' shop in Manila, at ₱35 (or slightly less) for the set.

You are directed to take up this matter with the provincial board and secure a resolution authorizing the purchase of the above-mentioned molds, of which one gang mold or one set of three alternative type molds for each concrete-construction job in progress simultaneously will, in most cases, be required. Upon securing favorable action from the provincial board a requisition on the Bureau of Supply for gang molds or upon the Bureau of Public Works for alternative type molds should be submitted in the customary manner. You are also requested to advise this Bureau as to the probable number of molds which will be requisitioned so that the order may be intelligently placed either through the Bureau of Supply with the manufacturers, or with the B. P. W. machine shop.

The approximate cost of a concrete test as specified in Constructing Division Circular No. 156 will be:

Materials: (8-inch diameter by 16-inch specimens) (paid by contractor, or from appropriation on administration work).....	a ₱1.00
Freight and packing average.....	b 1.00
Testing.....	b 2.00
Total.....	4.00
Total cost to district engineer's office.....	3.00
a Per set of 3 samples. b Per set of 2 samples.	

On the average, one set of samples per 12 cubic meters, of all classes of concrete, will be required. The additional cost will thus be about 22 centavos per cubic meter, which cost should be included and met as engineering expenses (A-7-1). This expense will not occasion an increase of more than 10 or 15 per cent in the provincial surcharge.

This circular should be cross-referenced to Constructing Division Circular No. 156.

For the Director:

D. E. HENRY,
Acting Chief Constructing Engineer.

To all DISTRICT ENGINEERS.
SENIOR SUPERVISING ENGINEERS.
CIVIL ENGINEERS ON SPECIAL DUTY.
CITY ENGINEER, *Baguio*.
Mr. J. H. CATON 3d, and
Mr. G. B. CANAGA.

MANILA, October 11, 1915.

Constructing Division Circular No. 161.

SIR: Attention is invited to the absolute necessity of stating the file number of plans from which the structure was built or otherwise specifically identify them on all requisitions for name plates. Difficulty has been experienced in identifying the plans of bridges and more especially bridges of the standard type to properly check name plate requisition, and to eliminate this difficulty, requisitions shall state the file number of the plans or otherwise specifically identify such bridges.

For the Director:

D. E. HENRY,
Acting Chief Constructing Engineer.

To all DISTRICT ENGINEERS.
SENIOR SUPERVISING ENGINEERS.
ENGINEERS ON SPECIAL DUTY, and
CITY ENGINEER, *Baguio*.

MANILA, October 27, 1915.

Constructing Division Circular No. 162.

SIR: Your attention is invited to the attached copy of Provincial Circular No. 126 of the Executive Bureau, dated October 22, 1915, relative to tablets or name plates for bridges, buildings or other public works, which circular amends and supersedes all previous instructions issued.

You are directed to familiarize yourself with the instructions contained in this circular of the Executive Bureau and carefully comply with same when submitting requisitions or requests for tablets or name plates for bridges, buildings or other public works in your district.

For the Director:

D. E. HENRY,
Acting Chief Constructing Engineer.

To all DISTRICT ENGINEERS.
SENIOR SUPERVISING ENGINEERS.
ENGINEERS ON SPECIAL DUTY.
CONSULTING ARCHITECT.
DESIGNING DIVISION, and
CITY ENGINEER, *Baguio*.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS,
EXECUTIVE BUREAU.

[Provincial Circular No. 126. Subject: Bridges and Buildings—Tablets or name plates for.]

MANILA, October 22, 1915.

Provincial Circular No. 67, of this office as amended by Provincial Circular No. 104, is hereby further amended to read as follows:

"For the purpose of standardizing tablets or name plates to be attached to bridges, public buildings, or other public works, the Director of Public Works has prepared a regulation specification which has been adopted and which will be used in the future wherever tablets or name plates are needed.

"Hereafter, provinces or municipalities desiring tablets or name plates for bridges, public buildings, or other public works, will make requisition on the Bureau of Public Works, giving the following information:

"(a) Name of public work.

"(b) Date of completion.

"(c) If provincial project, names of members of provincial board and provincial treasurer, or, if municipal project, names of the municipal president, secretary, and treasurer, in office when work was commenced.

"(d) Name of the District Engineer, with the prior approval of the Director of Public Works.

"(e) Name of contractor, if any.

"No names or information other than that above indicated will appear on the tablet or name plate, without the specific approval of the Governor-General."

By direction of the Governor-General:

(Sgd.) S. FERGUSON,
Acting Executive Secretary.

To all PROVINCIAL BOARDS.
PROVINCIAL TREASURERS.

MANILA, November 6, 1915.

Constructing Division Circular No. 163.

SIR: I have to invite your attention to the attached Provincial Circular No. 127 of the Executive Bureau, relative to the inspection and certification by the District Engineer of lumber purchased locally for public works in his district. Compliance with the instructions contained in the above mentioned Provincial Circular of the Executive Bureau is directed.

For the Director:

D. E. HENRY,
Acting Chief Constructing Engineer.

To all DISTRICT ENGINEERS.
SENIOR SUPERVISING ENGINEERS.
ENGINEERS ON SPECIAL DUTY.
CITY ENGINEER, *Baguio*.

THE GOVERNMENT OF THE PHILIPPINE ISLANDS,
EXECUTIVE BUREAU.

[Provincial Circular No. 127. Subject: Lumber purchased locally.—Inspection by district engineer before payment is made.]

MANILA, October 27, 1915.

Before making payment for lumber purchased locally for work under the direction of the district engineers, said lumber will be inspected by the District Engineer in accordance with Construction Division Circular No. 155, of the Bureau of Public Works, and the district engineer will certify on vouchers for payment of said lumber that it has been inspected and accepted.

(Sgd.) S. FERGUSON,
Acting Executive Secretary.

To all PROVINCIAL TREASURERS.

MANILA, December 11, 1915.

Constructing Division Circular No. 164.

SIR: The attention of district engineers is invited to the fact that Bureau clearances cannot be given them until they are relieved from custody of plans in district files, and books obtained from the bureau library, for which the bureau may hold their receipts. The responsibility for these items is identical with that for other Government property.

District engineers who are granted accrued leave, or vacation leave with permission to leave the Islands, should obtain from their successors receipts for such plans and books, and bring or send them to this office, whereupon their own receipts will be returned to them and clearance in this regard can be approved.

For the Director:

D. E. HENRY,
Acting Chief Constructing Engineer.

To all DISTRICT ENGINEERS.
SENIOR SUPERVISING ENGINEERS.
ENGINEERS ON SPECIAL DUTY.

CITY ENGINEER, *Baguio*.
Mr. J. H. CATON 3d.
Mr. ISABELO LAGNITON, *of Palawan*.
DESIGNING DIVISION.

MANILA, December 15, 1915.

Constructing Division Circular No. 165.

For your information, and in order to avoid the increasing amount of letter writing in connecting with statistical reports rendered

by district engineers I summarize present requirements as follows:

1. Corrected road diagrams must be forwarded to the Manila office in time to reach here on or before January 10 or July 10 as the case may be. Care should be taken to have the names of all towns mentioned on form 10a shown either on the road diagram itself or on the sketch at the foot of the road diagram.

2. Form 9 should be forwarded to the Manila office in time to reach here on or before January 10 or July 10 as the case may be, and should cover all the changes in structures during the half year for which the report is made. Structures eliminated should be shown in red, and if pipe or box culverts of a shorter span than $\frac{5}{10}$ of a meter are shown such items should be bracketed. There is no necessity of forwarding a complete list (series of Form No. 9) for the entire province. All that is necessary is data on the changes made in the half-year covered by the report. In case this office has reason to apprehend that errors exist in the bridge list, as corrected by means of these semiannual reports of changes in road structures, a complete set of forms will be made out and sent to the District Engineer with a special letter.

3. Form 194 must be forwarded to the Manila office in time to reach here on or before January 10 or July 10 as the case may be.

4. Form 67 must be forwarded to the Manila office monthly. The engineering surcharge is the sum of the regular provincial surcharge and the insular surcharge, the insular surcharge being figured on the sum of the regular charges and the provincial surcharge.

5. Form 10a must be forwarded to the Manila office monthly. *The blank spaces left for the "length maintained" must be filled out as otherwise no accurate average gang maintenance costs can be had.*

6. Form 200 must be forwarded to the Manila office on the last day of each month. (See instructions on back of form.)

The attention of all concerned is directed to the fact that the number of statistical reports required is now an irreducible minimum. If incomplete reports are sent in, or if reports are omitted from the series, or if the forwarding of the reports is delayed, this office has no option but to write a letter about the matter and secure correction of deficiency.

It is especially necessary that reports at the end of each half-year be forwarded without delay.

The entire series of reports, (items 1 to 6 above) together with road diagram, are to be submitted for provinces which recently came under the jurisdiction of the Bureau of Public Works, as soon as such action is feasible, considering each such province as a separate case.

For the Director:

D. E. HENRY,
Acting Chief Constructing Engineer.

To all DISTRICT ENGINEERS.
SENIOR SUPERVISING ENGINEERS.
ENGINEERS ON SPECIAL DUTY.
CITY ENGINEER, *Baguio*.

APPENDIX B.

MOTOR VEHICLES REPORTED AT THE BUREAU OF PUBLIC WORKS, MANILA, P. I., FROM SEPTEMBER 30, 1915, TO DECEMBER 31, 1915.

Register No. and type.	Owner's name.	Register No. and type.	Owner's name.
4151. Automobile.	Mariano Torres, Bago, Occidental Negros.	4243. Automobile.	Geo. W. de Armond, Ft. McKinley, Rizal.
4152. do.	Timoteo Unson, Pontevedra, Capiz.	4244. do.	O. M. Shuman, 119 Calle Cortada, Manila.
4153. do.	Carmelo Lizarraga, Iloilo, Iloilo.	4245. do.	A. T. Fajardo, 218 Nebraska, Manila.
4154. do.	Francisco Yulo, Iloilo, Iloilo.	4246. do.	Augusto Gonzales, Apalit, Pampanga.
4155. do.	Aniceto Jalbuena, Jaro, Iloilo.	4247. do.	Januario Villanueva, Sariaya, Tayabas.
4156. do.	Joaquin Gonzales, 915 Nueva, Malate, Manila.	4248. do.	Cipriano Cuarto, Tayabas, Tayabas.
4157. do.	Carlos Florentino, Vigan, Ilocos Sur.	4249. do.	Wm. F. Daland, 77 Nagtajan, Manila.
4158. do.	Manuel San Pedro, 817 Glovo de Oro, Manila.	4250. do.	Fermin Jimenez, 913 Aceyteros, Manila.
4159. do.	Jose Evangelista, Iloilo, Iloilo.	4251. do.	College of Medicine & Surgery, 547 Herran.
4160. do.	Vicente Montinola, Silay, Occidental Negros.	4252. do.	Carmen Vda. de Gerona, 739 Misericordia, Manila.
4161. do.	Sra. Concepcion Felix, 38 Lamayan, Manila.	4253. do.	Jose de Leon, San Miguel de Mayumo, Bulacan.
4162. do.	Roy J. Berry, 223 Gral. Luna, Manila.	4254. do.	Paz Agudelo, Bacolod, Occidental Negros.
4163. do.	Mrs. C. E. Haygood, 113 Nebraska, Manila.	4255. do.	Lt. Col. Grote Hutcheson, Ft. Wm. McKinley, Rizal.
4164. do.	Juan Villanueva, 645 Juan Luna, Manila.	4256. do.	O. Chu Cun, 179 Calle Barraca, Manila.
4165. do.	Mrs. J. Hofman, c/o Bachrach's Garage.	4257. do.	Maj. J. R. Lindsay, Regan Barracks, Albay.
4166. do.	Jose A. Barretto, 717 Kansas, Ave., Manila.	4258. do.	Simeon Blas, Flores, Malabon, Rizal.
4167. do.	Burt E. Grabo, Ft. McKinley, Rizal.	4259. do.	Jose Araneta, Mo'lo, Iloilo.
4168. do.	Baguio Transportation Co., Inc., Baguio.	4260. do.	Placido Escudero, San Pablo, Laguna.
4169. do.	E. G. Abbott, Ft. McKinley, Rizal.	4261. do.	Ty Chuaco & Company, 320 Santo Cristo, Binondo.
4170. do.	E. J. Westerhouse, Bureau of Public Works.	4262. do.	Lt. Col. A. W. Yates, Ft. Santiago, Manila.
4171. do.	Capt. Brice P. Disque, Ft. McKinley.	4263. do.	Judge Geo. R. Harvey, Court of First Instance, Manila.
4172. do.	R. E. Callen, 12 Military Plaza, Manila.	4264. do.	Ramon Rios, Rosario, Cavite.
4173. do.	Primo Hizon, 2209 Azcarraga, Manila.	4265. do.	Richard Sherran, Jolo, Sulu.
4174. do.	Agustin Alvarez, Gastambide, Sampaloc.	4266. do.	Jose A. del Prado, Paombong, Bulacan.
4175. do.	Fortunato Tanjutko, Hagonoy, Bulacan.	4267. do.	Jose Sampedro, 28 Ullilan Cauayan, Manila.
4176. do.	L. M. Southworth, Bachrach's Garage.	4268. do.	D. E. Miller, 120 Dasmariñas, Manila.
4177. do.	L. M. Southworth, Bachrach's Garage.	4269. do.	Romana V. Palacios, 11 Weyler, Iloilo.
4178. do.	I. C. Perez, 707 Lepanto, Manila.	4270. do.	C. Lozano, 19 Hughes, Iloilo.
4179. do.	Perfecto Gabriel, 612 Trinidad, Manila.	4271. do.	Celso Lobregat, 312 Gral. Luna, Manila.
4180. do.	H. H. Bayne, 918 Wright, Manila.	4272. do.	S. C. Choy, 672 Juan Luna, Manila.
4181. do.	W. Bruggmann, Tarlac, Tarlac.	4273. do.	Julia Vda. de Lopez, Bacolod, Occidental Negros.
4182. do.	Asiatic Petroleum Co., Pandacan, Manila.	4274. do.	Capt. Ernest E. Hazkell, Ft. McKinley, Rizal.
4183. do.	W. A. Muir, Iloilo, Iloilo.	4275. do.	Pedro Vlades, Bacolor, Pampanga.
4184. do.	P. H. Frank, Zamboanga, Mindanao.	4276. do.	R. L. Mosely, Capt. Phil. Scouts, Manila.
4185. do.	Prospero Dimayuga, Tanawan, Batangas.	4277. do.	Margaret Young, Fort McKinley, Rizal.
4186. do.	L. M. Southworth, Bachrach's Garage.	4278. do.	Stewart O. Elting, Quarters 72, Fort McKinley.
4187. do.	M. J. Ossorio, 39 Gral. Solano, Manila.	4279. do.	Lieut. C. W. McClure, Fort Wm. McKinley, Rizal.
4188. do.	Leandro Jabson, Malinao, Pasig, Rizal.	4280. do.	Maj. A. S. Fleming, Camp Stotsenburg, Pampanga.
4189. do.	Pedro Insuo, Pagbilao, Tayabas.	4281. do.	Le Vert Coleman, Manila Hotel, Manila.
4190. do.	Cipriano E. Unson, 613 Kansas, Manila.	4282. do.	Domingo Pablo, 71 Habana, Manila.
4191. do.	Daniel Boquer, 339 Herran, Manila.	4283. do.	Jose Lahoz, Vigan, Ilocos Sur.
4192. do.	Ade' L. de Mapa, Iloilo, Iloilo.	4284. do.	George Blakely, Army & Navy Club, Manila.
4193. do.	M. J. O'Doherty, Zamboanga, Mindanao.	4285. do.	Manuel J. de Laredo, 842 Lepanto, Manila.
4194. do.	Jose Ramos, Gapan, Nueva Ecija.	4286. do.	Hawaiian Sugar Planters Ass., Kneeder Building.
4195. do.	Jovito Baldomino, Tayabas, Tayabas.	4287. do.	James R. Leask, 747 Calle Dart, Paco, Manila.
4196. do.	Province of Laguna, Sta. Cruz, Laguna.	4288. do.	John T. Shepard, 573 General Luna, Manila.
4197. do.	Province of Tayabas, Lucena, Tayabas.	4289. do.	Justo Quesada, Santa Cruz Church, Manila.
4198. do.	Jose SyQuia, 906 Georgia, Manila.	4290. do.	Paul C. Hutton, Camp Stotsenburg, Pampanga.
4199. do.	W. M. Crooks, Cebu, Cebu.	4291. do.	M. V. Baylon, Manapla, Occidental Negros.
4200. do.	Clemente Puno, Guagua, Pampanga.	4292. do.	Benito Sy Congbieng, 123 Juan Luna, Binondo.
4201. do.	Zacarias Lichauco, 247 Aviles, Manila.	4293. do.	Paul H. Clark, Quarters No. 3, Fort McKinley.
4202. do.	Severino Gilbueno, 73 Gral. Luna, W. C.	4294. do.	Maria Roca de Martinez, Cebu, Cebu.
4203. do.	Ricardo Marcelino, Polo, Bulacan.	4295. do.	J. L. Manning, c/o Treasury Bureau, Manila.
4204. do.	Mrs. H. T. Fox, 361 Looban, Manila.	4296. do.	Luis P. Torres, 548 San Luis, Ermita, Manila.
4205. do.	W. H. Boynton, Y. M. C. A., Manila.	4297. do.	Walter Neumark, 132 Juan Luna, Binondo, Manila.
4206. do.	Aniceto Jalbuena, Jaro, Iloilo.	4298. do.	Arsenio N. Luz, 115 Padre Faura, Ermita, Manila.
4207. do.	Luzon Floral Company, 42 Escolta, Manila.	4299. do.	Lucio Ongsiao, 725 Calle Tabora, Tondo, Manila.
4208. do.	Macleod & Co., Manila.	4300. do.	Leon Borrero, c/o Philippine Assembly, Manila.
4209. do.	W. F. Stevenson & Co. Ltd., Manila.	4301. do.	Cirila Arcinas, 64 Calle Tejeron, Santa Ana.
4210. do.	Jorge B. Vargas, 803 D. Alfonso, Manila.	4302. do.	Manuel de Yriarte, c/o Executive Bureau, Manila.
B-4211. do.	Miguel Lloret, 264 Sta. Mesa, Manila.	4303. do.	James C. R. Schroeck, Quarters No. 54, Ft. McKinley.
4212. do.	Concepcion Teus, 167 Gral. Luna, Manila.	4304. do.	Mrs. Margaret Lloret, 142 Sociego, Manila.
4213. do.	Estrella Auto. Palace, Manila.	4305. do.	Jose Lino Luna, 1650 Rizal Ave., Manila.
4214. do.	Angel Valenzuela, Guagua, Pampanga.	4306. do.	Anselmo Sinjian, San Fernando, Pampanga.
4215. do.	P. H. Frank, Zamboanga, Mindanao.	4307. do.	T. P. Merchant, Kneeder Building, Manila.
4216. do.	Gregorio Olegario, 763 Sto. Cristo, Manila.	4308. do.	Consuelo Rozas, 223 Concepcion, Manila.
4217. do.	John Helbig, 1282 M. H. del Pilar, Manila.	4309. do.	Domingo Diaz, Tabaco, Albay.
4218. do.	L. S. Cairns, c/o M. E. R. R. & L. Co.	4310. do.	Rev. Mariano Baluyot, Barili, Cebu.
B-4219. do.	Antonio de Quesada, 17 N. Domingo, San Juan del Monte Rizal.	4311. do.	Luis R. Yangco, 628 Herran, Manila.
4220. do.	Adelaida Abreu de Holman, 19 A. Mabini, Manila.	4312. do.	Joaquin Bas, 132 San Marcelino, Manila.
4221. do.	Province of Occidental Negros, Bacolod, Occidental Negros.	4313. do.	Leyte Land Transportation Co., Tacloban, Leyte.
4222. do.	Mariano B. Arroyo, Iloilo, Iloilo.	4314. do.	Philippine General Hospital, Manila.
4223. do.	Mariano B. Arroyo, Iloilo, Iloilo.	4315. do.	Victor Buencamino, 2229 Azcarraga, Manila.
4224. do.	Rafael Palma, 553 Leroy, Manila.	4316. do.	Manuela Reyes Vda. de Marzano, 543 Tandauy, Manila.
4225. do.	Rafael Monserrat, Lingayen, Pangasinan.	4317. do.	Capt. G. R. Allin, Camp Stotsenburg, Pampanga.
4226. do.	Sanitary Steam Laundry, 918 Arlegui, Manila.	4318. do.	Bureau of Internal Revenue, Manila.
4227. do.	Ananias Taylo, 501 Lara, Manila.	4319. do.	Leyte Land Transportation, Tacloban, Leyte.
4228. do.	Braulio Aus, 521 Sta. Mesa, Manila.	4320. do.	Leyte Land Transportation, Tacloban, Leyte.
4229. do.	Felipa Acosta de Salas, Vigan, Ilocos Sur.	4321. do.	Rev. Father Alejandro Espina, Dumanjuc, Cebu.
4230. do.	Jose Vinas, 1142 Misericordia, Manila.	4322. do.	Rafael Singson, 48 Calle Pienza, Malabon, Rizal.
B-4231. do.	Josefa R. Vda. de Wilson, 135 San Nicolas, Manila.	4323. do.	Dr. Pedro Ycasiano, 234 Lorenzo Chacon, Manila.
4232. do.	D. M. Fleming, 35 Manga Ave., Manila.	4324. do.	Jr. S. K. Everett, Pasay, Rizal, P. O. Box 133, Manila.
B-4233. do.	Adriano Florencio, 817 Honradez.	4325. do.	Pacific Commercial Company, Plaza Moraga, Manila.
4234. do.	Otege Hashimoto, Iloilo, Iloilo.	4326. do.	J. T. Conrad, Fort William McKinley, Rizal.
4235. do.	Gordon McPherson, Manila Polo Club, Manila.	4327. do.	Manuel Lopez, 932 Singalong, Manila.
4236. do.	Jose Bustamante, 413 Sto. Cristo, Manila.	4328. do.	Teodoro de los Reyes, 2157 Azcarraga, Manila.
4237. do.	Walter Smith Co. Inc., Iloilo, Iloilo.	4329. do.	Antonio Melian y Pavia, 4 Nebraska, Ermita, Manila.
4238. do.	Nicolas Borrero, Silay, Occidental Negros.	4330. do.	Adela C. Baldwin, Muntinlupa, Taguig.
4239. do.	Gregorio Jalbuena, Jaro, Iloilo.	4331. do.	L. M. Southworth, Bachrach's Garage & Tax. Co.
4240. do.	J. M. Gouldner, Silver Dollar Garage, Melba, Manila.	4332. do.	Jose Lim Chumbuque, 59 Valderrama, Manila.
B-4241. do.	Anacleto Lauchang, Malabon, Rizal.	4333. do.	Perfecto J. Salas Rodriguez, 1517 Azcarraga, Manila.
4242. do.	E. V. Platt, Manila Hotel, Manila.	4334. do.	Jose B. Suntay, Hagonoy, Bulacan.
		4335. do.	

Motor vehicles reported at the Bureau of Public Works, Manila, P. I., from September 30, 1915, to December 31, 1915—Continued.

Register No. and type.	Owner's name.	Register No. and type.	Owner's name.
4336. Automobile.....	Dalmacio Olegario, 2141 Herran, Manila.	4089. Tricycle.....	Calamba Sugar Estate, San Fernando, Pampanga.
4337. do.....	Bureau of Science, Manila.	4090. Motorcycle.....	Gil Ramos, Quingua, Bulacan.
4338. do.....	Isabel C. Perez, 707 Lepanto, Manila.	4091. do.....	Silverio de Guzman, 740 Rizal Ave., Manila.
4068. Motorcycle.....	E. D. Gavagan, Medical Supply Depot, Manila.	4092. do.....	Jose B. Lopez, Hinigaran, Occidental Negros.
4069. Tricycle.....	Jose J. Eugenio, 77 Legaspi, Manila.	4093. do.....	George C. Barlett, San Lazaro Fire Station, Manila.
4070. do.....	Province of Cavite, Cavite, Cavite.	4094. do.....	Geo. W. Viley, 319 Sto. Sepulcro, Manila.
4071. Motorcycle.....	Walter B. Bost, Tagbilaran, Bohol.	4095. do.....	Jesus Rivera, Cagayan, Misamis.
4072. do.....	Province of Bohol, Tagbilaran, Bohol.	4096. Tricycle.....	Municipality of Zamboanga, Zamboanga, Mindanao.
4073. Tricycle.....	Maximo Constantino, 735 T. Alonzo, Manila.	4097. Motorcycle.....	Matt. D. Taylor, 734 Zacateros, Manila.
4074. Motorcycle.....	Jacinto Damian, 45 Dagupan, Manila.	4098. do.....	Manuel Salcedo, Albay, Albay.
4075. Tricycle.....	Ah Hui, 329 Caballero, Manila.	4099. do.....	Dionisio Fernandez, San Fernando, Pampanga.
4076. Motorcycle.....	H. W. Besch, Capi, Capi.	5001. Tricycle.....	Edward McClure, 58 Int. Villaruel, Pasay, Rizal.
4077. do.....	Erlanger & Galinger, Manila.	5002. Motorcycle.....	Henry Reiland, 625 Honradez, Sampaloc, Manila.
4078. do.....	J. R. Corbin, Manila Hotel, Manila.	5003. do.....	Province of Zamboanga, Mindanao.
4079. do.....	A. C. Spong, Manila Fire Department, Manila.	5004. Tricycle.....	James F. Godward, Jr., San Jose, Antique.
4080. Tricycle.....	Lawrence A. Cooper, Laoag, Ilocos Norte.	5005. Motorcycle.....	R. Dixon, 707 Wright, Manila.
4081. Motorcycle.....	F. W. Scheben, Iloilo, Iloilo.	5006. Tricycle.....	Thomas E. Snyder, Private, Precinct 4.
4082. do.....	Singer Sewing Machine Co., Cebu, Cebu.	5007. do.....	Celestino Navarro, Laoag, Ilocos Norte.
4083. do.....	Vicente B. Oledan, Cabanatuan, Nueva Ecija.	5008. do.....	J. M. Kerr, San Fernando, Pampanga.
4084. do.....	N. G. Nelson, Naval Station, Cavite.	5009. Motorcycle.....	F. D. Scott, Guinobatan, Albay.
4085. do.....	Faustino Zabaljuarequi, La Estrella del Norte, Iloilo, Iloilo.	5010. do.....	Charles M. Bond, Cebu, Cebu.
4086. do.....	W. M. Smith, Olongapo, P. I.	5011. do.....	William R. McInteer, Olongapo, P. I.
4087. do.....	R. W. Noon, Y. M. C. A., Manila.	5012. Tricycle.....	Julian Santiago Roxas, Marilao, Bulacan.
4088. do.....	L. S. Spafford, Ft. McKinley, Rizal. (c/o Lt. Van Deusen.)	5013. do.....	Ed. B. Shay, 228 Anda, W. C.

APPENDIX C.

PROJECTS ACTIVE OCTOBER 1, 1915.

Provinces.	Roads and trails.				Bridges and culverts.				Provincial administration buildings.			Municipal administration buildings.			Prisons.			Schools.				Construction and operation.										Total.		
	Construction.	Maintenance.	Repair.	Reconstruction.	Construction.	Maintenance.	Repair.	Reconstruction.	Construction.	Maintenance.	Repair and altera- tion.	Construction.	Reconstruction.	Maintenance.	Construction.	Repair and altera- tion.	Maintenance.	Construction.	Maintenance.	Repair and altera- tion.	Reconstruction.	Markets and tiendas.	Parks, grounds, and athletic fields.	Miscellaneous build- ings.	Ferries.	Water systems.	Record vaults.	Quarries.	Telephone lines.	Electric-light plants.	Miscellaneous.			
Albay	1				2					1				1				4						3								1	16	
Ambos Camarines	6	8			2	2				1		2					1	5	1			4		1									34	
Antique	3	2			2					1								1															8	
Bataan	3						1																			2							15	
Batangas	4	3			2	1		1		1	1	1				1		4	2		1	3	1	3		1							34	
Bohol	3	3			4													3								1							15	
Bulacan	1	4								1								3				3											14	
Cagayan	4				3	1				1		1				1		1	3					1	1								26	
Capiz	2	2	3	1	7													4						2		1							24	
Cavite	6	2			2													4															16	
Cebu	6	2	1		2													4															27	
Ilocos Norte	2	2					1											4		1		2	1	5		1							12	
Ilocos Sur	11	3	1		1	1							1					6		1		3		1		2	1						37	
Iloilo	8	3	1		1		1					2		1				8				3	1	1		1			1				37	
Isabela	4	2			1	1												1					1										12	
Laguna	3		1		4													9					2				2						30	
La Union	7	2			1													7				2				1							22	
Leyte	1	2	1	1	7													4															18	
Misamis	4	2			2													2		1													17	
Nueva Ecija	3				1													4					5	1									16	
Occidental Negros	12	2			5													2					4			1							3	
Oriental Negros	6	4			2					2								3					4				1							24
Pampanga	4	2					1											6			1		1	1									19	
Pangasinan	7	3		4	3													4					1		1								27	
Rizal	3	7			5													4			1												20	
Samar	5	2																2															14	
Sorsogon	5	7			1				1							1		2					1										10	
Surigao	2	2																5		3													28	
Tarlac	4	3										1						3					1										13	
Tayabas	5	3			1					1								2					1	2									15	
Zambales		4			9																		1	1			1						1	
Total	135	95	8	6	71	6	3	3	1	9	1	10	1	1	1	3	1	109	6	5	3	44	9	23	9	11		2	2		68	646		

NOTE.—The 68 projects under the caption "Miscellaneous" represent 5 surveys and investigations of roads, bridges, water systems, etc., 3 dikes, 3 wharves, 2 irrigation systems, 2 river controls, 1 harbor maintenance, 1 auto line, etc.

BUREAU OF PUBLIC WORKS

ORGANIZATION

WARWICK GREENE (Absent), *Director of Public Works*
E. J. WESTERHOUSE, *Acting Director of Public Works*
G. C. FENHAGEN, *Consulting Architect*
C. E. GORDON, *Chief Designing Engineer*
H. F. CAMERON, *Senior Supervising Engineer, Mindanao and Sulu*

C. LINDSEY, *Assistant to the Director*
HAROLD N. GRAVES, *Chief Accountant*
J. R. KUYKENDALL, *Acting Property Clerk*

L. L. COOK, *Superintendent of Automobiles*
JOSE VENTANILLA, *Record Clerk*

CONSTRUCTING DIVISION

D. E. HENRY, *Acting Chief Constructing Engineer*
Wm. RADER, *Acting Superintendent of Artesian Wells*

DISTRICT ENGINEERS

Brown, E. C...... Albay, Albay
Bogges, L. S...... Naga, Ambos Camarines
Segura, Valeriano..... San Jose, Antique
Williams, A. D...... Baguio, Benguet
Francisco, Luis..... Balanga, Bataan
Marshall, J. T...... Batangas, Batangas
Harrison, J. L...... Malolos, Bulacan
Vallarta, Julian..... Tagbilaran, Bohol
Barry, R. L...... Tuguegarao, Cagayan
Bennett, C. R...... Cavite, Cavite
Sjovall, A. H...... Capiz, Capiz
Russell, Claud..... Cebu, Cebu
Haley, A. E...... Cotabato, Cotabato
Phipps, C. E...... Davao, Davao
Morrison, C. G...... Iloilo, Iloilo
Gomez, Pastor..... Laoag, Ilocos Norte
Smith, E. D...... Vigan, Ilocos Sur
Macaraeg, Juan..... Ilagan, Isabela
Kasilag, Marcial..... San Fernando, La Union
Barry, J. R...... Los Baños, Laguna

Clark, L. T...... Tacloban, Leyte
Meehleib, H. R...... Dansalan, Lanao
Caton, J. H. 3rd..... Manila
Scheidemantel, L. W...... Cagayan, Misamis
Honska, W. B...... Calapan, Mindoro
Austin, A. W...... Cabanatuan, Nueva Ecija
Palmer, W. C. A...... Bacolod, Occidental Negros
Grosvenor, I. R...... Dumaguete, Oriental Negros
Halsema, E. J...... San Fernando, Pampanga
Dandois, Chas. S...... Lingayen, Pangasinan
Brown, L. R...... Pasig, Rizal
Hulse, S. W...... Catbalogan, Samar
Lilley, H. B...... Sorsogon, Sorsogon
Ines, Leon..... Surigao, Surigao
Schenk, E. E...... Jolo, Sulu
Agcaoili, Romarico..... Tarlac, Tarlac
Sylvester, A. T...... Lucena, Tayabas
Orosa, Vicente..... Iba, Zambales
Cookingham, J. C...... Zamboanga, Zamboanga